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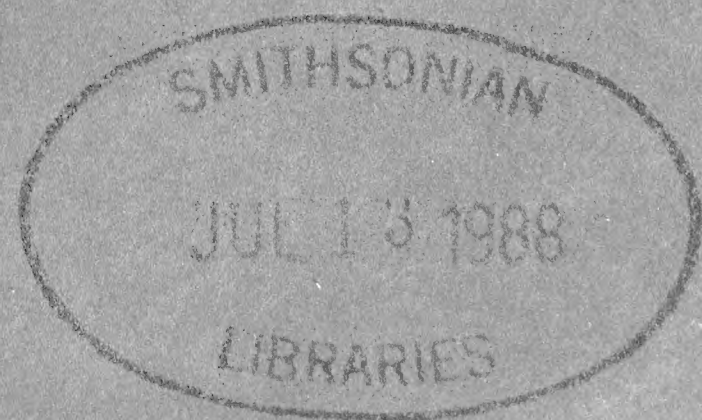
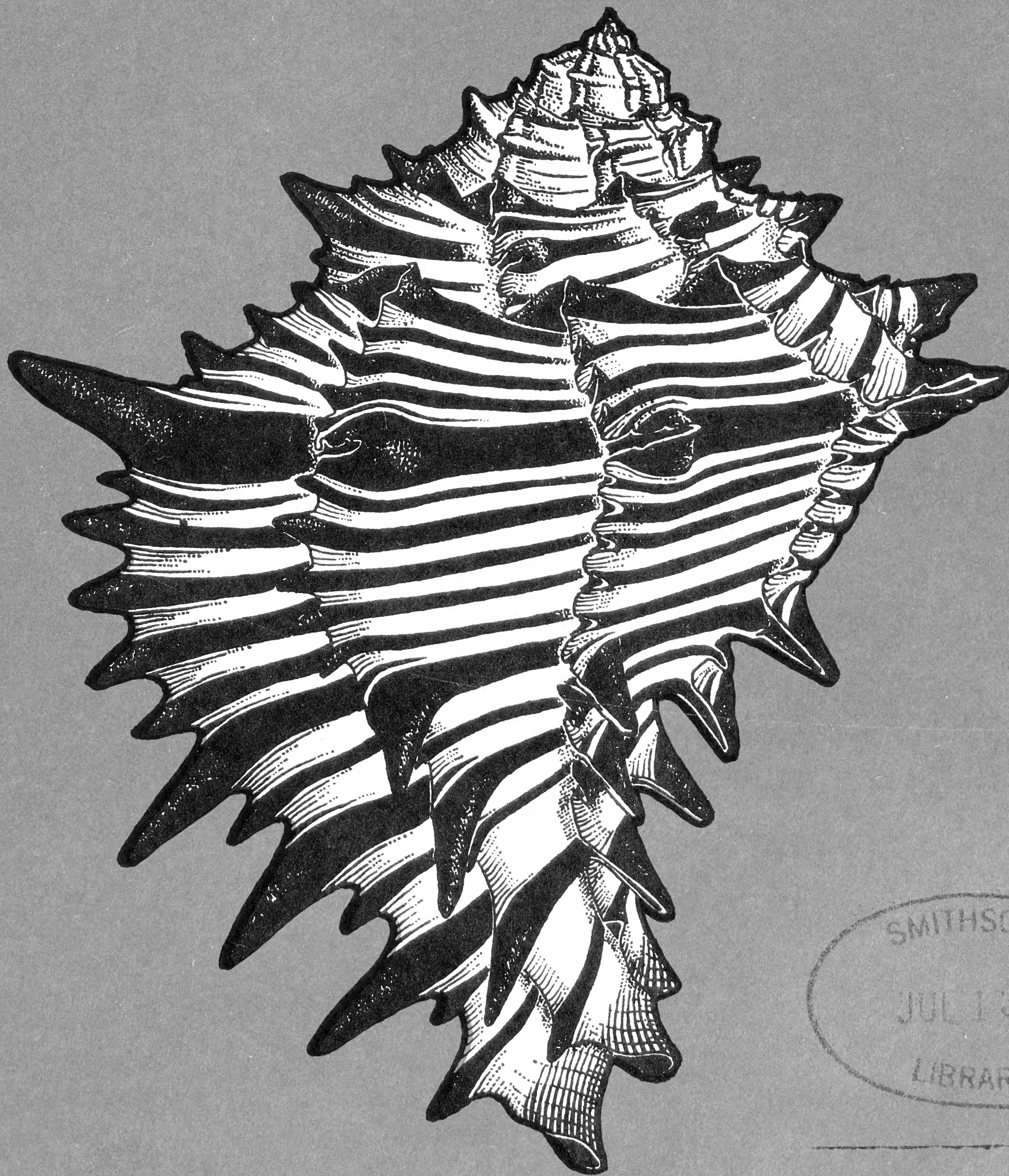
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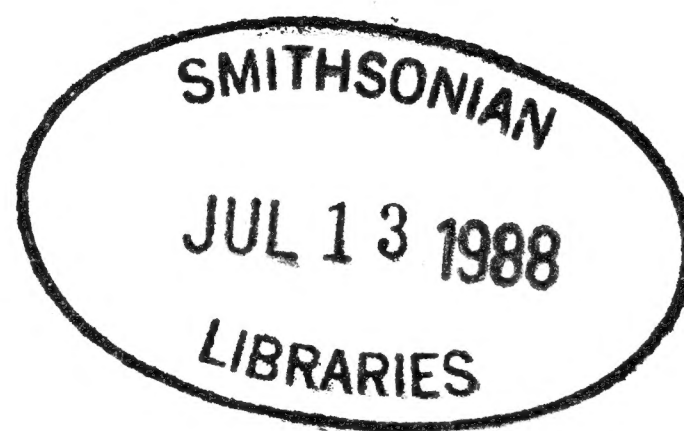
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THE MARGINELLIDS OF SÃO TOMÉ, WEST AFRICA

SERGE GOFAS¹ AND FRANCISCO FERNANDES²

(Accepted for publication, 21st November 1987)



Abstract: Marginellids (Mollusca, Gastropoda) of the Island of São Tomé, West Africa, are revised and seven new species are described: *Marginella spinacia*, *Volvarina insulana*, *Granulina parilis*, '*Cystiscus*' *gutta*, *Gibberula modica*, *Gibberula punctillum*, *Gibberula cucullata*. Morphology and polychromatism of soft parts are described and importance of these characters for taxonomy of this family is emphasized. A neotype is designated for *Marginella festiva* Kiener.

Résumé: Les Marginellidae (Mollusques, Gastropodes) de l'île de São Tomé (Afrique occidentale) sont révisés, et sept espèces nouvelles sont proposées: *Marginella spinacia*, *Volvarina insulana*, *Granulina parilis*, '*Cystiscus*' *gutta*, *Gibberula modica*, *Gibberula punctillum*, *Gibberula cucullata*. Des notes sur la morphologie et le polychromatisme sont présentées, en attirant l'attention sur l'importance de ces caractères pour la taxonomie des petites espèces de cette famille. Un néotype est désigné pour *Marginella festiva* Kiener.

Resumo: Uma revisão é feita dos Marginellidae (Moluscos, Gasterópodos) da ilha de São Tomé (Africa occidental), com sete novas espécies descritas: *Marginella spinacia*, *Volvarina insulana*, *Granulina parilis*, '*Cystiscus*' *gutta*, *Gibberula modica*, *Gibberula punctillum*, *Gibberula cucullata*. São apresentados apontamentos sobre a morfologia e o policromatismo, frisando a importancia destas características para o reconhecimento das pequenas espécies nesta família. Um neotipo é designado para *Marginella festiva* Kiener.

The Neogastropod family *Marginellidae* is an important part of the West African molluscan fauna, and the species are diverse and abundant in a variety of marine environments. Twelve species are known to us from the island of São Tomé (Gulf of Guinea), all but one different from mainland species. Seven of them are new and described herein.

This study is intended to emphasize the importance of observation on living animals for the systematics of this family. Previously, taxonomy has been based mostly upon shell characters, which are often inadequate for species discrimination. The polychromatism of the mantle and foot has been found useful to recognize small species where the shell is rather featureless. At the generic level, the morphology of head, foot and mantle, as well as some attitudes of living animals, add consistent characters in complement to shell morphology. In the long run, observation of living specimens of generotypes should contribute to a revised classification of this family.

The radulae have been studied for some species. When present, it has only the central tooth developed. It is mostly helpful for taxonomy at generic, not specific level.

Material examined

The material for this study has been collected between low water mark and -5 m. The algal mat or underpart of stones was brushed and collected in a net of 0.5 mm mesh mounted on a suitable frame. The residue was immediately sieved in sea water (mesh 5 mm, 1 mm and 0.35 mm). The coarse fraction can be sorted under the naked eye; the others are placed in a bucket with clean sea water for the molluscs to creep out. The fast moving marginellids are among the first to show.

¹ Elf-Aquitaine, 64018 Pau, and M.N.H.N., Paris, France

² Cx.P. 12427, Luanda (Angola).



Map 1. Simplified map of the island of São Tomé, to show localities of collecting (italics).

Our collecting localities (map 1) are mostly located on the North shore of the island. We have visited them in November of 1983 (S.G.), November of 1985 (F.F., S.G.) and December of 1986 (F.F.)

Sant'Ana and south of town of *São Tomé*, algal mat on stones in 1 to 5 m depth, moderately surfed area.

Praia Emilia, just north of the town; a sheltered place with many dead coral blocks in 1 to 2 m.

Praia das Conchas (township of Guadalupe), and nearby *Praia Morro Peixe*, a moderately surfed area with the greatest development of live corals (*Siderastrea*, *Porites*)

Esprainha (township of Neves) on both sides of the wharf, in 1 to 5 m bottoms of boulders covered by a dense algal mat (mostly Coralline red Algae); there are very few Corals. At the NE end of this site, facing the mouth of a small stream, a patch of muddy sand in 3–4 m has also been prospected.

Part of this material is presently in F. Fernandes' private collection, another part in Museum National d'Histoire Naturelle (Laboratoire de Malacologie) in Paris. All designated holotypes are in MNHN. Paratypes have been sent to various institutions, as listed.

We have examined the original material of Tomlin and Shackleford (1912, 1913) in the

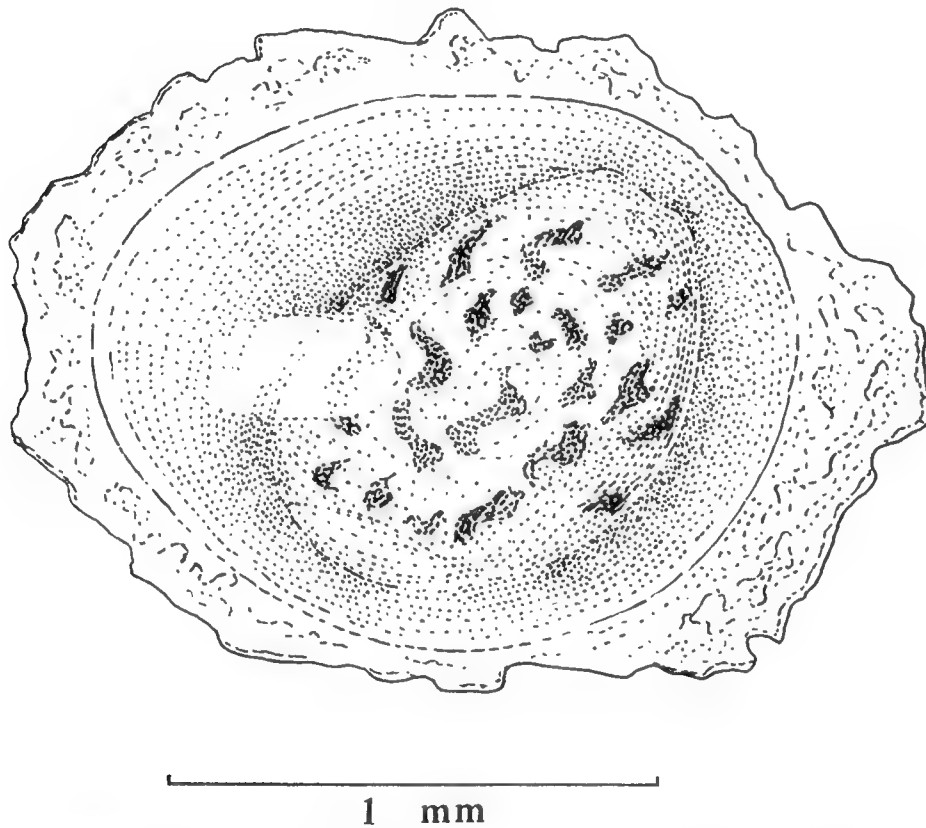


Fig. 1. Egg capsule of *Marginella spinacia* n. sp., containing one developed embryo. Esprainha, in 3–5 m depth. Scale bar is 1 mm.

National Museum of Wales (Cardiff). Type material of *Marginella liparozona*, *M. melvilli* and *M. eveleighi* is figured or refigured.

A few lots in MNHN, Paris, originating either from São Tomé (“Calypso” cruise in Gulf of Guinea; specimens purchased from Preston and probably of the same source as Tomlin and Shackleford’s) or from Principe island (Navel collection, 1920) have also been studied.

Reproduction, dispersal

The paucispiral character of the protoconch in all the species considered here suggests a direct larval development, without planktonic stage, as is usual in the family. We have observed egg capsules of *Marginella spinacia* n. sp. (Fig. 1) with easily recognizable larval shells. Several other marginellid egg capsules have also been seen but could not be assigned to one or another species. There is always a single embryo developed. The capsules are attached to the substrate (commonly algae) by their basal surface.

Egg capsules of *Marginella eveleighi* are reported by Knudsen (1950), attached to a decaying leaf (Nigeria, ‘Atlantide’ station 104, 4°30’N, 5°23’E, 50 m).

As a consequence of lacking a planktonic stage, it is assumed that none of the species described here can exist on both sides of the Atlantic. Only one of the insular species, *Marginella eveleighi*, is found also on the mainland, in Gabon (Bernard, 1984), Cameroon and Nigeria (Knudsen, 1956). However, *M. melvilli*, *M. liparozona*, *Volvarina insulana* n. sp. and *Persicula thomensis* are found on both São Tomé and Principe islands, without conchological variation being more conspicuous than within São Tomé itself. The most likely means of dispersal, in this case, is by egg capsules torn away with their algal substrate.

Acknowledgements

The authors are indebted to A. Warén (Swedish Museum of Natural History, Stockholm) for mounting the radulae, and to P. Bouchet (MNHN, Paris) for taking S.E.M. photographs. Dr. Graham Oliver kindly brought for us to Paris the Tomlin and Shackleford collection of Marginellids from National Museum of Wales, Cardiff. We also thank Dr. Y. Finet (Muséum d’Histoire Naturelle, Genève) for sending the photographs of *Marginella festiva* and *P. pulchella*.

SYSTEMATIC PART

Notes on the descriptions

For consistency between description of shell and soft parts, the words 'anterior' and 'posterior' have been preferred to 'superior' and 'inferior', commonly applied to shells. This terminology refers to the position of the shell on the living animal: the abapical ('inferior') part of shell is anterior and bears the siphonal canal; the adapical ('superior') part is posterior.

Abbreviations used in text

MNHN: Muséum National d'Histoire Naturelle, Paris – Laboratoire de Malacologie.

BMNH: British Museum (Natural History), London.

IIT: Instituto de investigação Tropical (Centro de Zoologia), Lisbon.

MHNG: Museum d'Histoire Naturelle, Geneva.

NMW: National Museum of Wales, Cardiff.

SAM: South African Museum, Cape Town.

UAN: Universidade Agostinho Neto (Faculdade de Ciências, dep. Biologia), Luanda.

FF: Private collection of F. Fernandes.

'Specimens' refers to specimens collected alive, as opposed to 'shells'.

Genus **Marginella** Lamarck, 1799

Type species: *Voluta glabella* Linné, 1758 by monotypy.

Shell 5 to 50 mm in length, with moderately elevated spire and glossy porcelaneous surface, generally colourful. Columella with four definite, subequal plaits in its anterior half. Outer lip thickened, denticulated inside. Siphonal canal not deeply incised.

Head bifurcated, with slender tentacles and eyes in small bulges laterally to the base of the tentacles. Siphon large and protruding over the head.

Foot large, creeping flat on the substrate, slightly longer than the shell when extended. The mantle is not visible through the shell, and hardly extends over the shell when the animal is moving (sometimes a small lobe can be seen on the left side).

No radula could be found in the species (*M. spinacia* n. sp.) examined for this character. The lack of a radula has already been reported for other species of *Marginella* (Graham 1966, Ponder 1970).

Marginella spinacia n. sp. (Figs. 2, 3; Pl. 1C)

Etymology: from Linnean Latin name of spinach (allusive to the greenish colour of the shell).

Previous reference: *Marginella festiva* (non Kiener): Tomlin and Shackleford (1913b), p. 43, Pl. 1, Figs. 3–4.

Type material: Holotype, Fig. 2: Esprainha, collected alive (MNHN). Paratype, Fig. 3: Praia das Conchas.

Unfigured paratypes: Esprainha, numerous specimens (MNHN, IIT, NMW, SAM, UAN, FF). Mutamba, 10 specimens (FF). Praia das Conchas, 2 specimens (MNHN, FF). Praia Morro Peixe: 8 specimens (MNHN). South of town of São Tomé: numerous specimens (FF); Sant'Ana: 10 specimens (FF). Island of São Tomé (locality unspecified): several shells labelled '*Marginella festiva* Kiener' in Tomlin collection (NMW).

Shell 7 to 8 mm in length (Holotype: 7.2 mm), with rather high spire and indistinct suture. Outer lip thickened, with strong, uneven denticles on the inner side. Aperture rather narrow with parallel sides. There are two spiral zones of greenish patterns on the median part of the body whorl, bordered with darker projections and bearing several spiral lines of dots. The subsutural area and the anterior part of the shell have some less definite greenish blotches. Three pink spiral bands, plain or interrupted, commonly alternate with

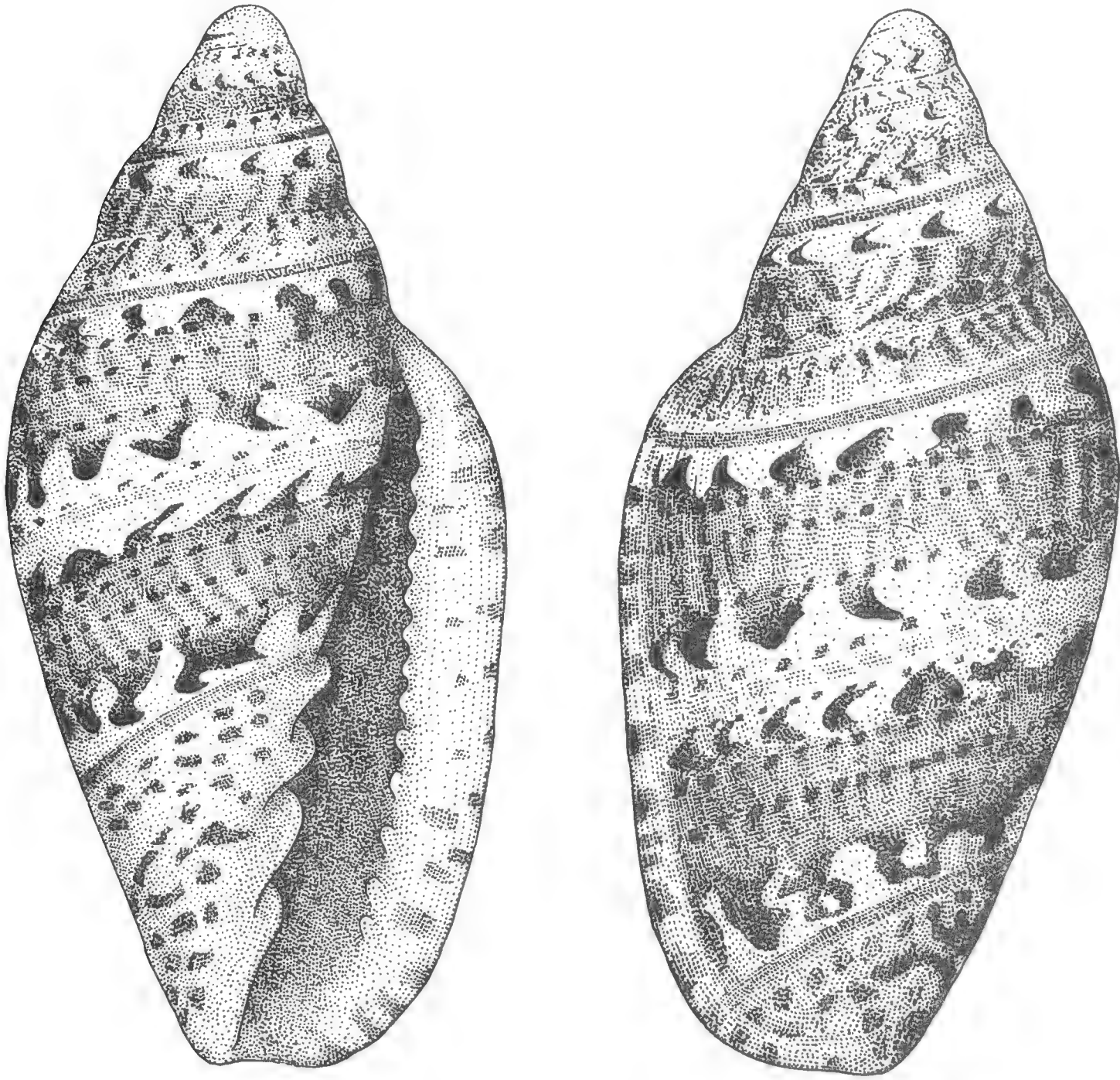


Fig. 2 a,b. *Marginella spinacia* n. sp.: holotype, Esprinha, 3–5 m. Actual size 7.2 mm.

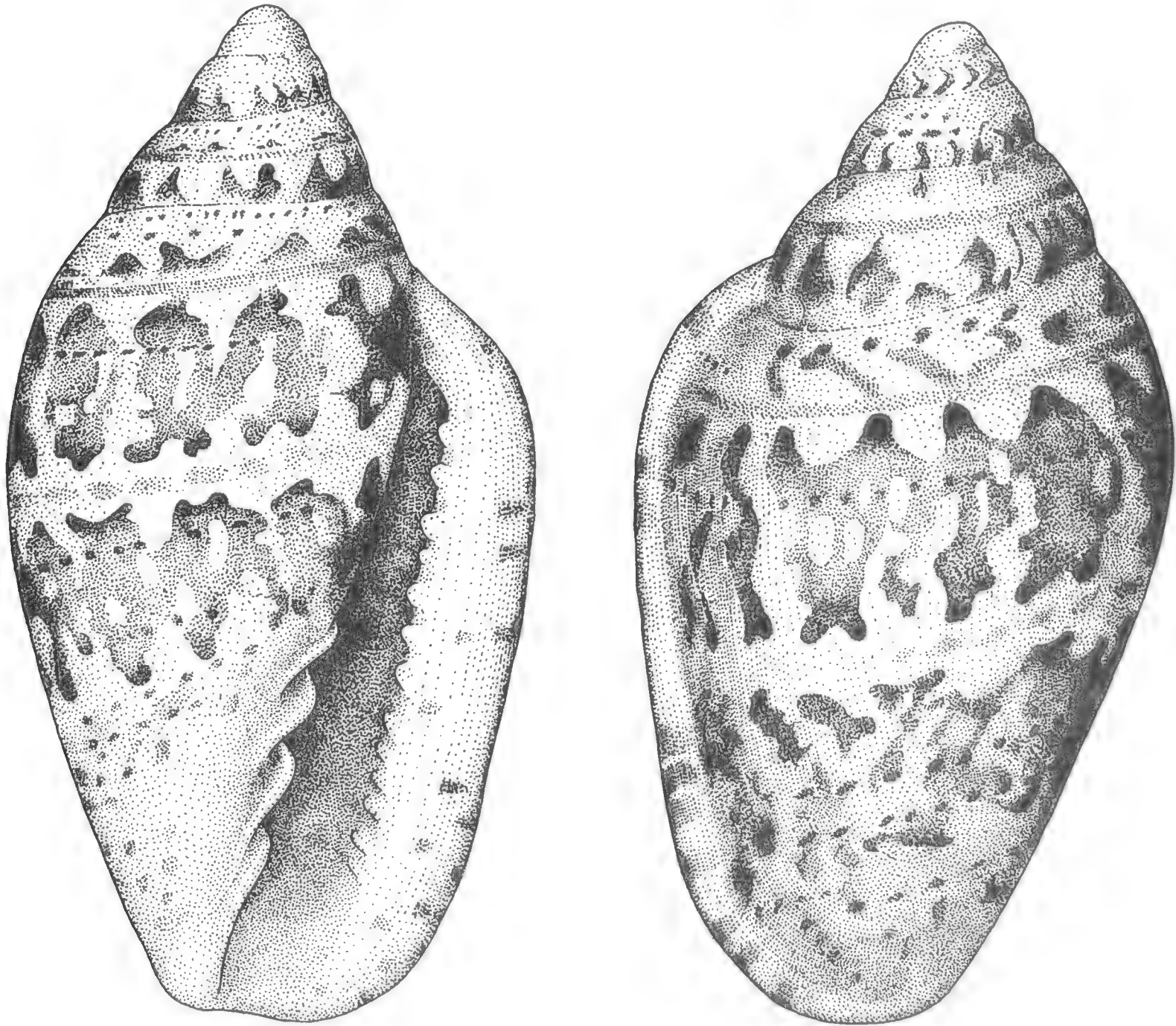


Fig. 3 a,b. *Marginella spinacia* n. sp.: paratype, Praia das Conchas, 1–2 m. Actual size 7.8 mm.

the greenish designs. There are some greenish blotches on the outer lip.

Head, tentacles, foot and siphon are sprinkled with cream yellow (dominant) and rusty flecks; the former coalescent to form larger blotches towards the inner part of the foot.

Remarks

Tomlin and Shackleford (1913) have mentioned and figured this species as *Marginella festiva* Kiener. We have, in an appendix of this paper, designated as neotype of *M. festiva* a specimen from the Delessert collection in Geneva (MHNG no. 986.662). The peculiar colour pattern in the shell of *M. festiva* cannot be found in any species known to us from São Tomé or from the neighbouring mainland, and we therefore consider *M. festiva* sensu Tomlin and Shackleford as an unnamed species.

We have observed a geographic variation among the live collected populations of *M. spinacia* n. sp. in São Tomé. At Esprainha (type locality: rocky bottom with dense algal mat) and Mutamba, the shell is rather small (7 to 7.5 mm) and narrow with dark greenish markings and intense pink bands (Fig. 2, Pl. 1C); the soft parts show a high density of rusty flecks all over. At Praia das Conchas and Praia Morro Peixe (area with coral grounds), the shell is larger, more inflated, with paler green markings and hardly any pink bands (Fig. 3); the soft parts are mostly cream yellow with few rusty flecks. At São Tomé and Sant'Ana, specimens are not very different from those of Praia das Conchas.

Conversely, each one of the populations we have studied is remarkably homogeneous both for morphology and colour pattern.

Marginella spinacia n. sp. resembles *M. gemmula* Bavay in Dautzenberg, 1913 and undescribed species from the Angolan coast. The shell of *M. gemmula* has a different polychromatism; the soft parts are coloured of small bright yellow dots without any rusty flecks.

Habitat

Marginella spinacia n. sp. has been found on infralittoral (2–5 m) hard bottoms, within dense algal mat with agglutinated sediment, also in fissures between stones or under stones with deposits of fine grained sediment. At Esprainha, where it is most abundant, a single stone can carry dozens of specimens.

Marginella melvilli Tomlin and Shackleford, 1913 (Figs. 4, 5)

Original reference: Tomlin and Shackleford (1913a), p. 11, Pl. 1, Figs. 1–2.

Type material: Holotype (no. 1955–158–1094): Island of São Tomé (Tomlin collection, NMW).

Other material examined: South of town of São Tomé, 2 specimens (FF, December 1986); Principe Island, 1 shell (Navel collection, MNHN).

Shell 8 to 9 mm in length (holotype 8.5 mm with broken apex), with moderately high spire and rounded apex. Outer lip thickened, with about ten denticles decreasing in size anteriorly. Aperture broader in its anterior two thirds. There are, on the body whorl, two spiral zones of greenish brown markings, each with large triangular, darker projections alternating on either side. The subsutural area has a similar, but paler, design. The outer lip may bear some brownish blotches.

The foot and tentacles are covered with small yellow flecks. The siphon is opaque white, slightly tinged with yellowish towards the tip.

Remarks

This species is exceedingly rare compared to the previous one. Conchologically, it is not very different from *M. liparozona*.

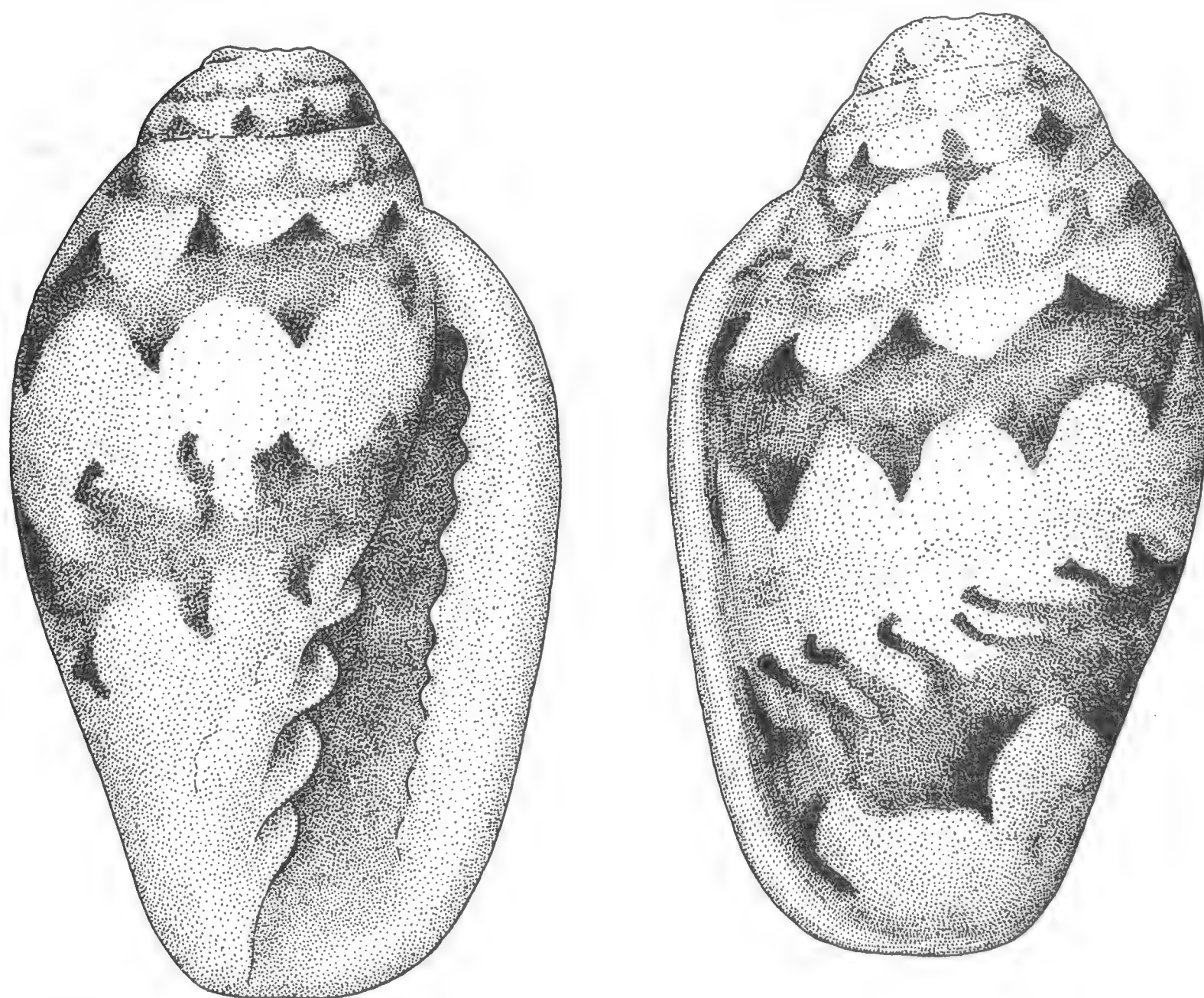


Fig. 4 a,b. *Marginella melvilli* Tomlin and Shackleford: holotype, São Tomé island (NMW 1955-158-1094). Actual size 8.5 mm.

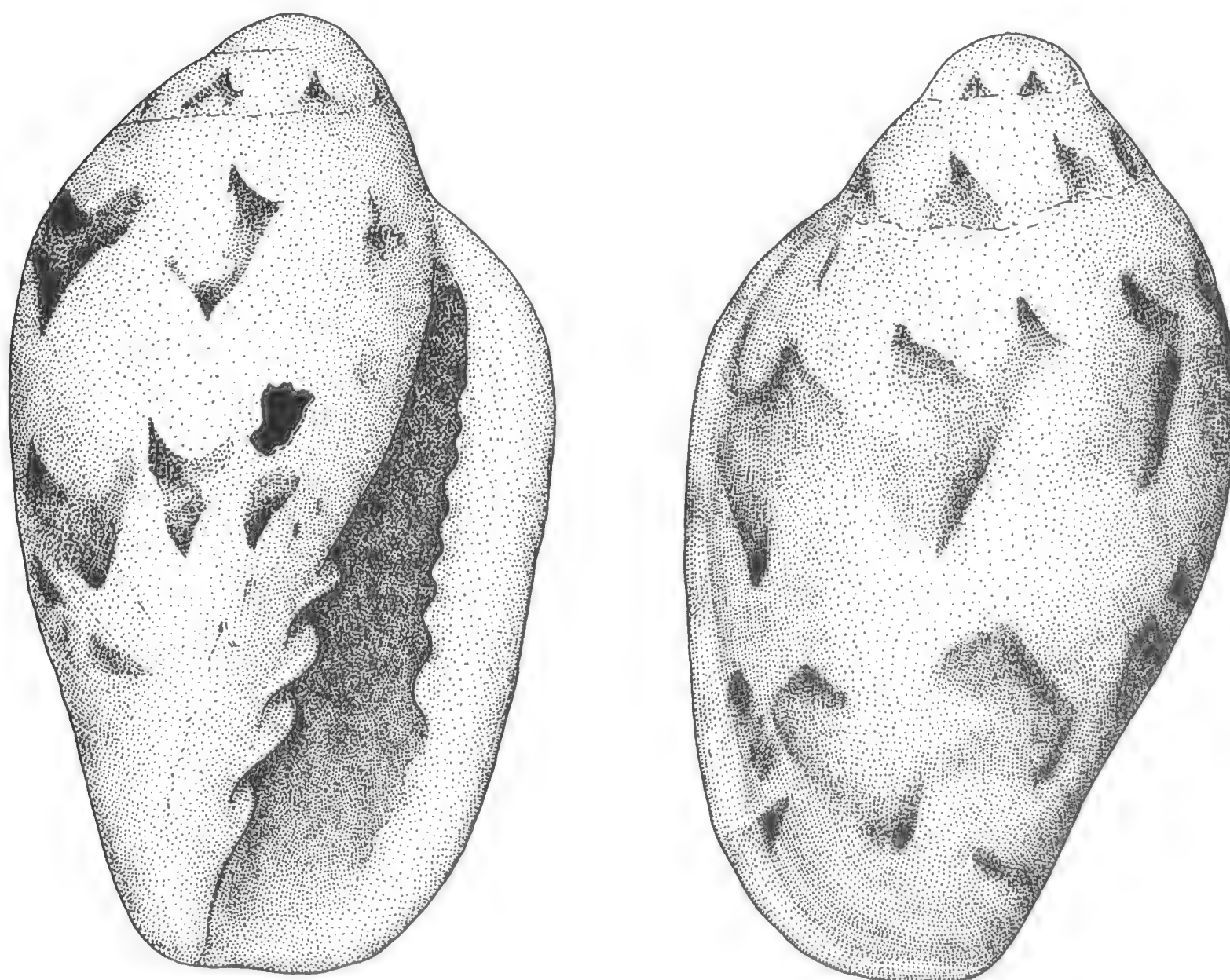


Fig. 5 a,b. *Marginella melvilli* Tomlin and Shackleford: Principe island (Navel collection, MNHN). Actual size 8.3 mm.

In our opinion, the specimen from 'Galathea' St. 50, Ilheu das Rolas, 5–8 m, illustrated by Knudsen (1956, Pl. 3, Fig. 4) as *M. festiva* should be referred to *M. melvilli*.

Habitat

The only live collected specimens of this species have been found at 2–3 m depth, under a loose stone clear of sediment.

Marginella liparozona Tomlin and Shackleford, 1913 (Figs. 6–9).

Original reference: *Marginella festiva* (non Kiener): Reeve (1865), Pl. 19, Fig. 93. – *M. liparozona*: Tomlin and Shackleford (1913b), p. 43.

Type material: Lectotype (here designated) (no. 1955–158–1093) and 2 paralectotypes: Island of São Tomé (Tomlin collection, NMW). 3 paralectotypes, unknown origin (Cuming collection, BMNH).

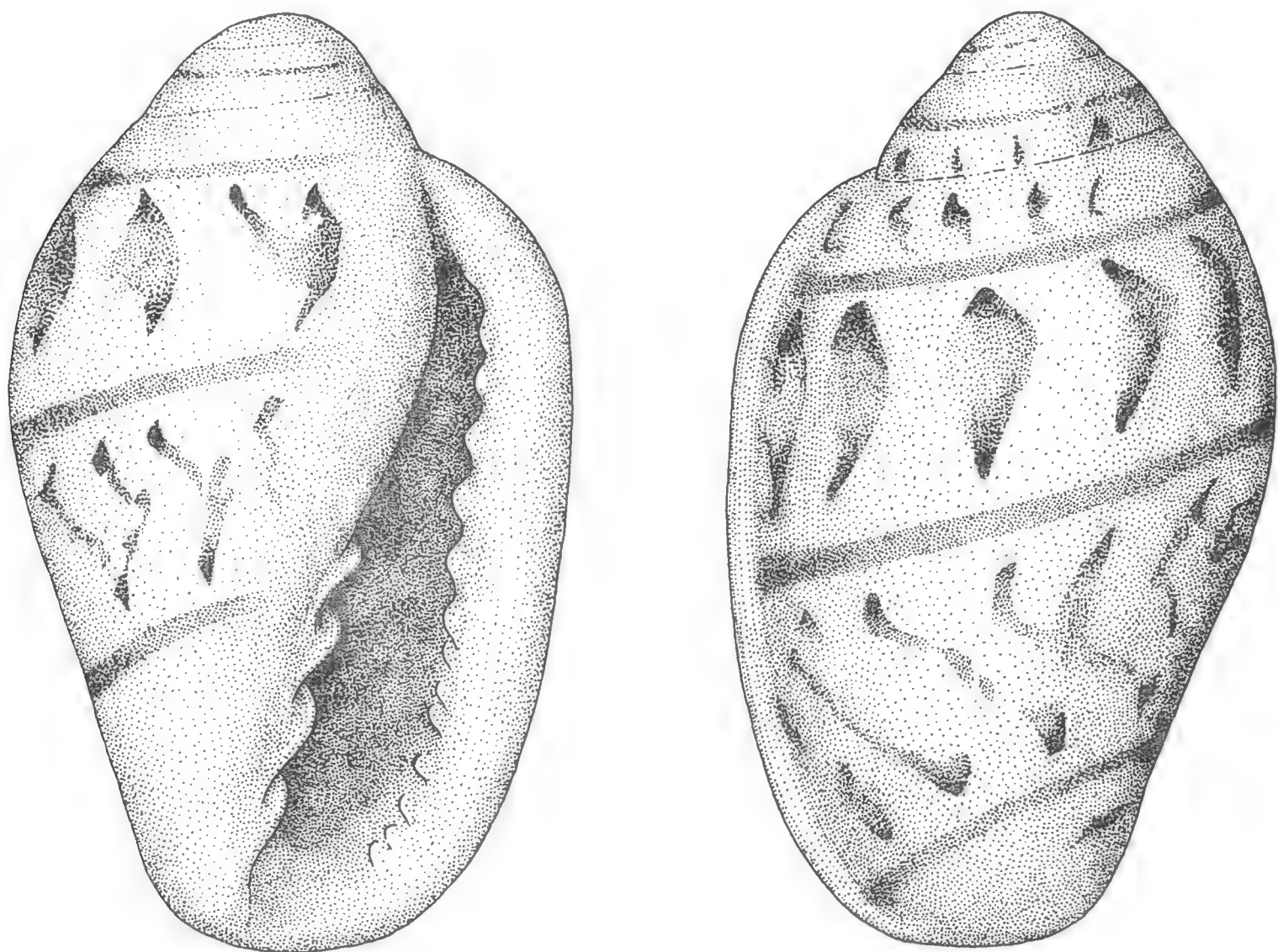


Fig. 6 a,b. *Marginella liparozona* Tomlin and Shackleford: lectotype, São Tomé island (NMW no. 1955–158–1093). Actual size 7.4 mm.

PLATE 1 (opposite)

Living animals of *Marginella*, *Volvarina* and *Persicula*.

A. *Marginella chalmersi* Tomlin and Shackleford: Praia Emilia. Length of shell 6 mm.

B. *Marginella eveleighi* Tomlin and Shackleford: Praia das Conchas, close to a small stream.

C. *Marginella spinacia* n. sp.: Esprainha. Length of shell 7.3 mm.

D. *Volvarina insulana* n. sp.: Esprainha. Length of shell 7 mm.

E. *Persicula thomensis* Tomlin: Praia das Conchas. Length of shell 7 mm.

PLATE 2 (overleaf)

Living animals of 'Cystiscus', *Granulina* and *Gibberula*.

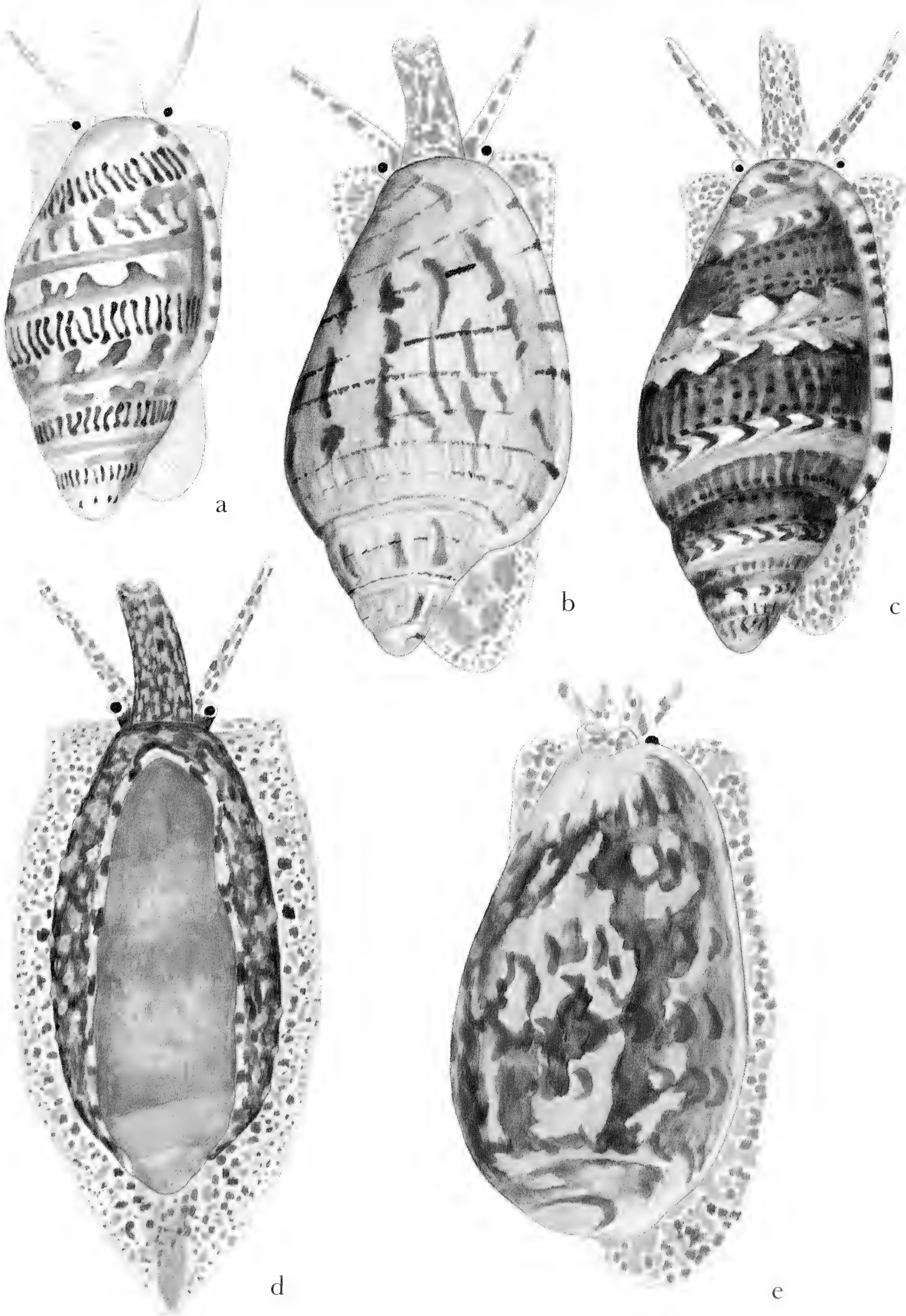
A. 'Cystiscus' *gutta* n. sp.: Esprainha. Length of shell 2.6 mm.

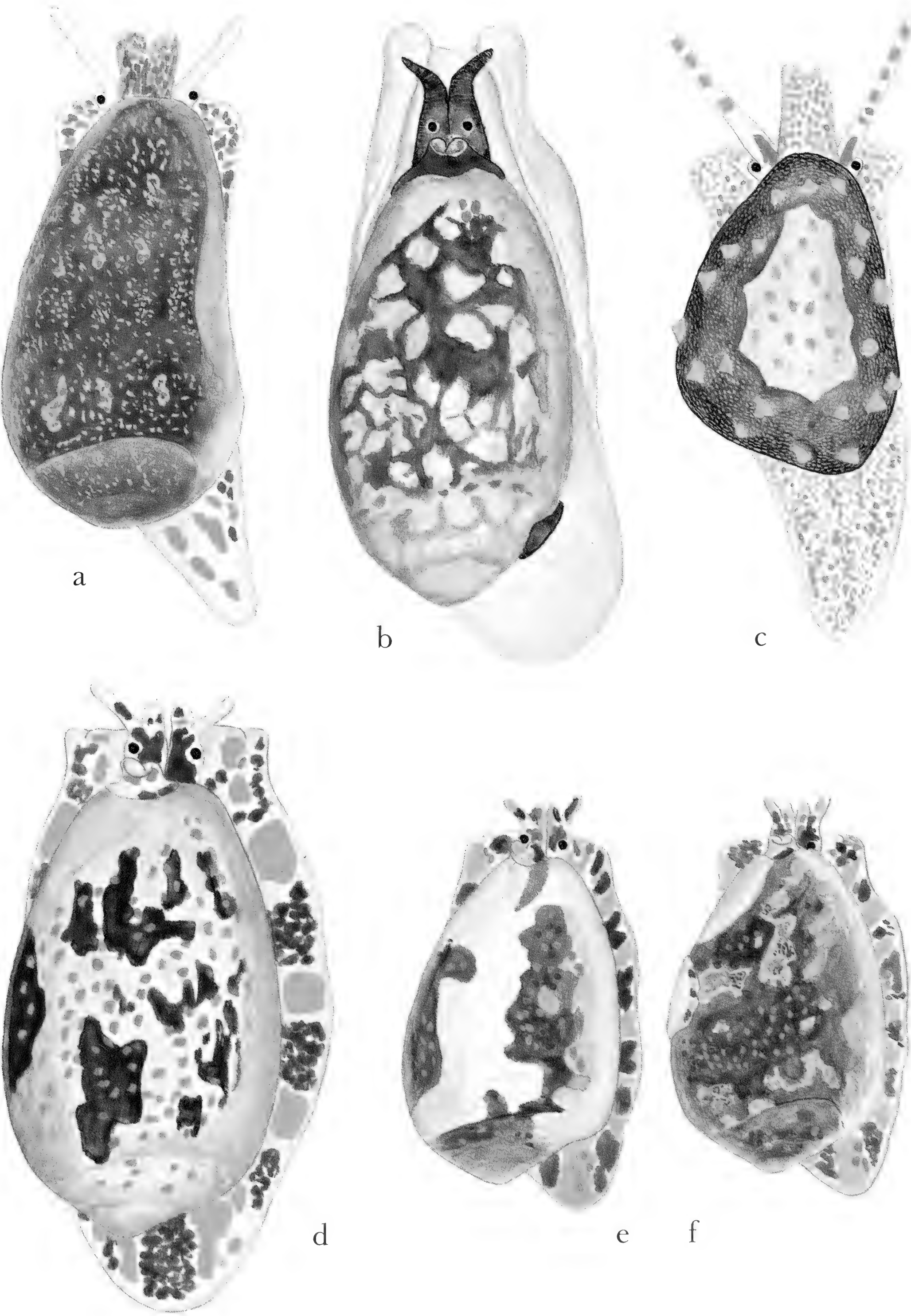
B. *Gibberula cucullata* n. sp.: Esprainha. Length of shell 2.6 mm.

C. *Granulina parilis* n. sp.: Esprainha. Length of shell 1.9 mm.

D. *Gibberula modica* n. sp.: Esprainha. Length of shell 3.3 mm.

E, F. *Gibberula punctillum* n. sp.: Esprainha. Length of shell 1.9 mm.





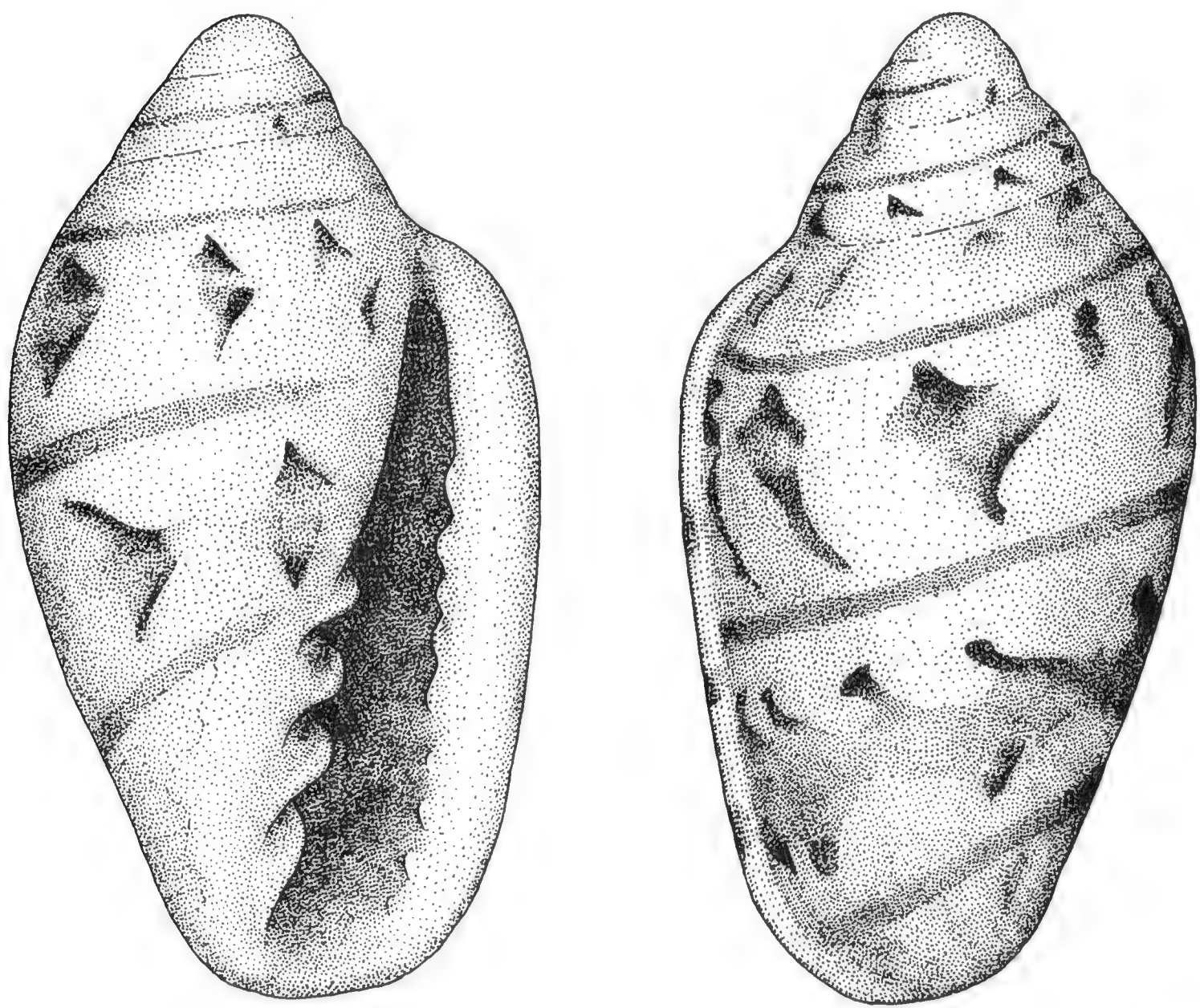


Fig. 7 a,b. *Marginella liparozona* Tomlin and Shackleford: Principe island (Navel collection, MNHN). Actual size 8·8 mm.

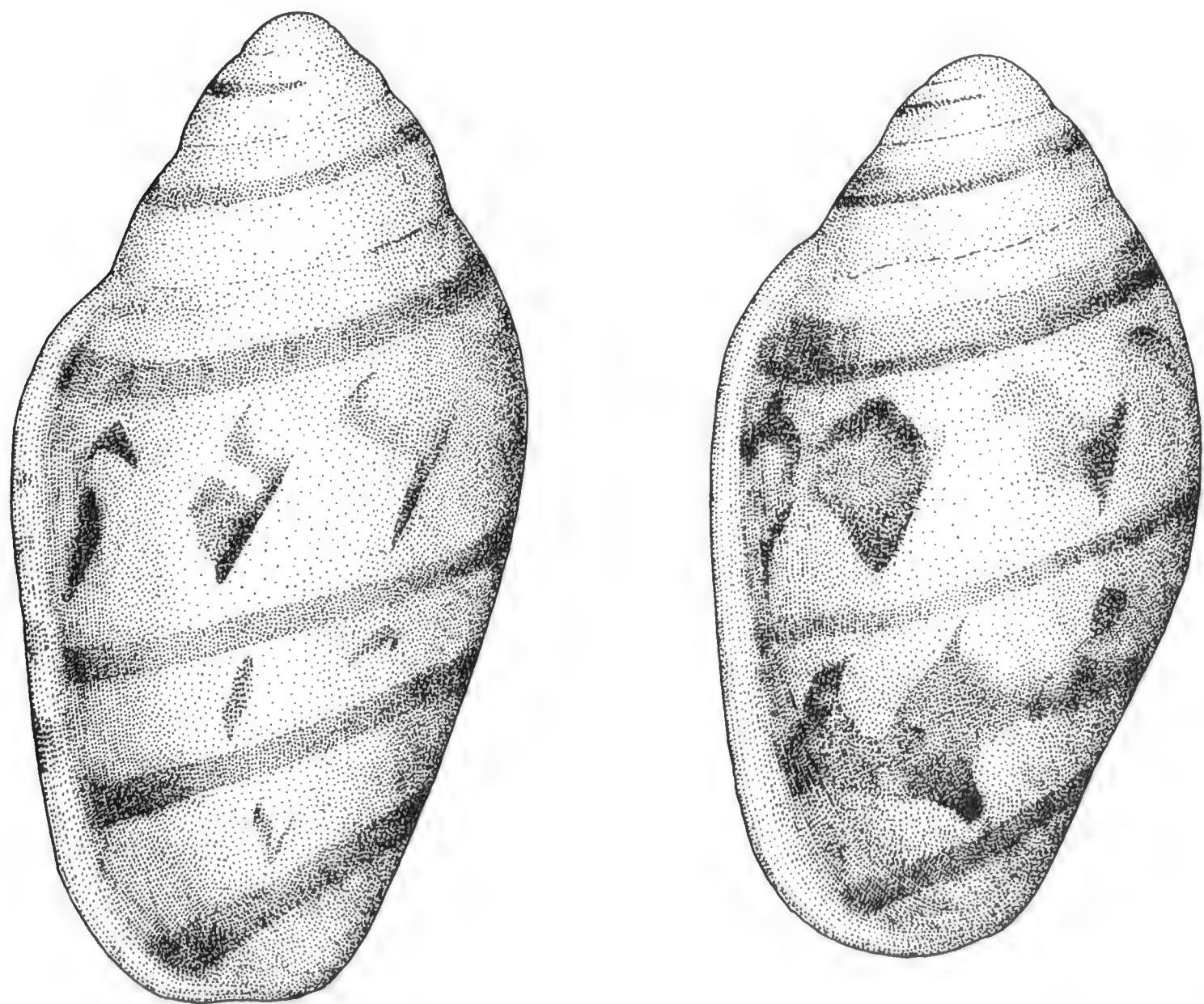


Fig. 8, 9. *Marginella liparozona* Tomlin and Shackleford: Principe island (Navel collection, MNHN): colour variants. Actual sizes 8·8 and 8·0 mm.

Other material examined: Principe island, 11 shells (Navel collection, 1920, MNHN); beach of Santo Antonio, Principe island, 2 shells (Calypso cruise "Gulf of Guinea", st. 22, MNHN).

Shell 7 to 10 mm in length (lectotype 7.4 mm), with a moderately high spire and a rounded apex. Outer lip thickened, with a dozen denticles decreasing anteriorly in size. Aperture broader in its anterior two thirds. There are usually, on the body whorl, two spiral series of brown markings, with darker projections, alternating with three plain pink bands. There are some less distinct brown markings along the subsutural area. The outer lip may bear some brown blotches. Animal unknown.

Remarks

The name *M. liparozona* has been introduced by Tomlin and Shackleford (1913), based upon a figure given by Reeve (1865, vol. 15, Pl. 19, Fig. 93) for *Marginella festiva* Kiener, and upon additional material from São Tomé. Three specimens of this species, from the Cuming collection are presently in BMNH, and one of them is presumably the specimen illustrated by Reeve. They are more similar to our material from Principe (Navel coll.) than to Tomlin's original material.

The type locality of *M. liparozona*, implicitly understood, is the island of São Tomé, and Reeve's statement of origin 'East Africa' is disputed by Tomlin and Shackleford. Their specimen of *M. liparozona* in NMW is here selected as lectotype and figured for the first time (Fig. 6).

The shell of *M. liparozona* differs from that of *M. melvilli* mostly by the presence of pink bands. This character has been seen to occur in some populations and not in others of *M. spinacia* n. sp., and thus may not be significant. An observation of living animals is necessary to determine if *M. liparozona* should be, or not, considered a junior synonym of *M. melvilli*.

We have studied a series of eleven shells from Principe island (Navel collection, 1920, MNHN). The shell illustrated, Fig. 7, resembles very much the lectotype of *M. liparozona*, from which it differs mostly by the less globose apex. Other shells (Figs. 8, 9) have a different colour pattern, with an additional pink stripe replacing the anterior series of brown markings.

We could not succeed in finding this species in São Tomé. Until any specimens are found, it cannot be ruled out that Tomlin and Shackleford's specimen, as well as Reeve's, should actually come from Principe.

Marginella chalmersi Tomlin and Shackleford, 1912 (Figs. 10, 11; Pl.1A).

Original reference: Tomlin and Shackleford (1912), p. 320, Pl. 4, figs. 3–4.

Type material: Holotype in BMNH.

Other material examined: South of town of São Tomé: 50 specimens (FF). Praia Emilia: 20 specimens (MNHN, FF). Esprinha: 1 specimen (FF). Mutamba: 1 specimen, juvenile (MNHN). São Tomé island (unspecified locality): 3 shells (purchased Preston, MNHN); 2 shells (Tomlin collection, NMW).

Shell up to 6 mm in length, with a rather high spire and rounded apex. Suture indistinct. Outer lip thickened, with a dozen uneven denticles. There are, on the body whorl, two spiral zones with dense longitudinal lineoles, bordered by irregular, paler yellowish brown stains; a reddish or brownish spiral band runs in between these on the middle part of the body whorl. The outer lip bears a few dark blotches.

The foot is sprinkled with tiny cream-white flecks; these are also seen on the head, but become denser with a rather yellow hue towards the tip of the tentacles. The siphon is opaque white.

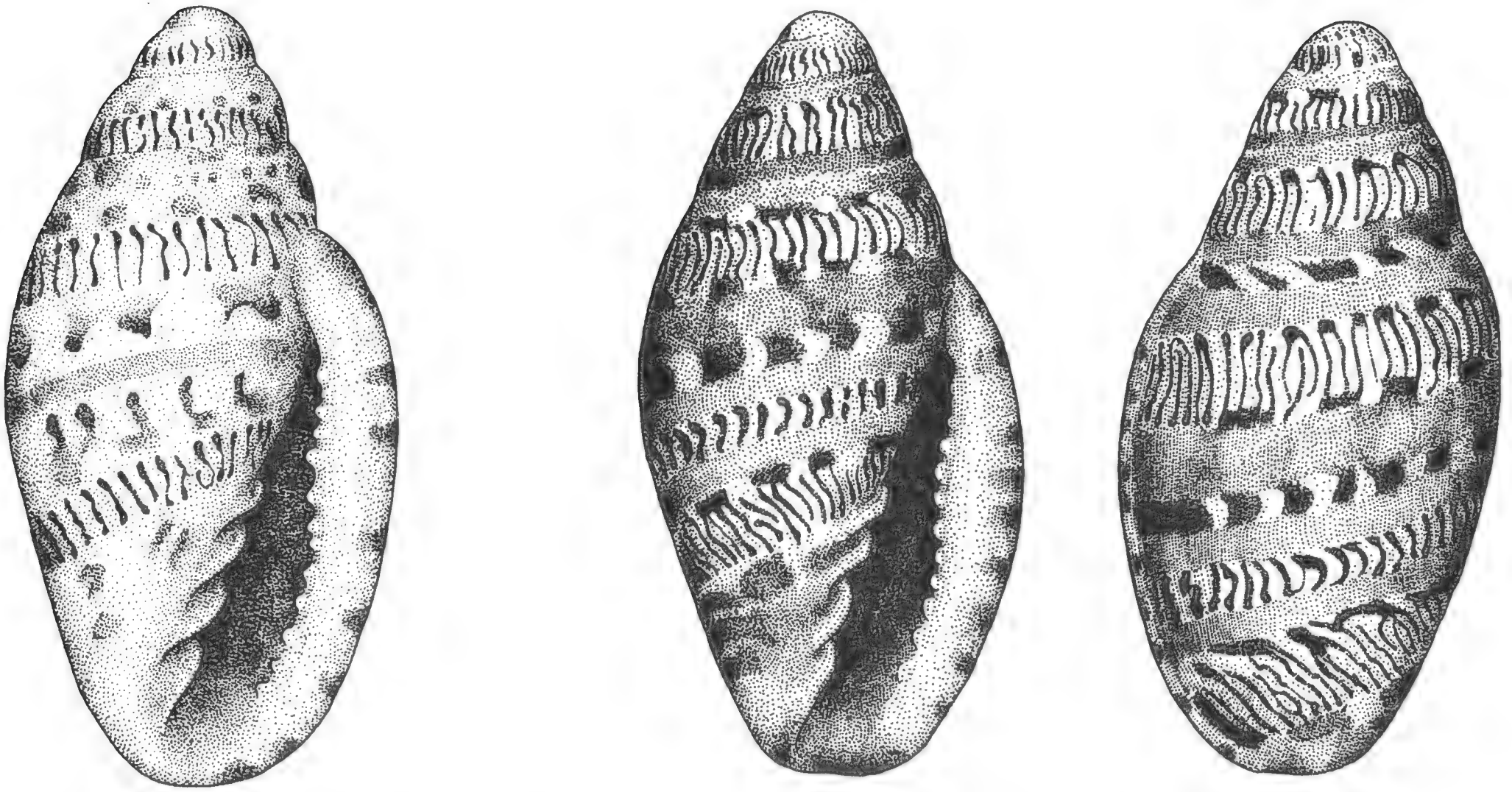


Fig. 10. *Marginella chalmersi* Tomlin and Shackleford. Praia Emilia, 1–2 m. Actual size 6.0 mm.

Fig. 11 a,b. *Marginella chalmersi* Tomlin and Shackleford. Esprinha, 3–5 m. Actual size 5.6 mm.

Remarks

Specimens from Esprinha (Fig. 11) and Mutamba are darker than those around the town of São Tomé.

Habitat

Marginella chalmersi has been found on stones embedded in sand, where sediment is agglutinated by small filamentous algae in the vicinity of soft bottoms. It is exceedingly rare at Esprinha where the dominant species is *M. spinacia*.

Marginella eveleighi Tomlin and Shackleford, 1913 (Figs. 12,13; Pl. 1B)

Original reference: Tomlin and Shackleford (1913a), p. 11, Pl. 1, figs. 5–6.

Type material: Holotype (no. 1955–158–1091): São Tomé island (Tomlin collection, NMW).

Other material examined: Esprinha, 7 specimens (FF). Praia das Conchas, 15 specimens (FF). Baia de Ana Chaves (facing town of São Tomé), 1 shell (Calypso cruise ‘Gulf of Guinea’, MNHN). Banié, Libreville and Port Gentil, Gabon: 10 specimens (collected by P. Bernard, MNHN).

Shell 6 to 9 mm in length (holotype: 6.2 mm) with a rather high conical spire and axial folds on the shoulder. Outer lip strongly thickened, with 11–12 denticles. Colour pattern of black spiral lines, which can be interrupted, and irregular longitudinal flames, on a greyish or whitish background.

Foot translucent, with small yellow spots grading towards the inner areas to larger, paler, cream-yellow blotches. Head and tentacles with a series of yellow spots. Siphon densely covered with yellow blotches, with slightly more intense hue than head and foot.

Remarks

There is no appreciable difference between shells of *Marginella eveleighi* of São Tomé and those from Gabon figured by Bernard (1984) p. 89, Fig. 159, as *M. tyermani* Marrat. The specimens figured by Bernard, p. 89, Fig. 157 as *M. eveleighi* are larger (15 mm) and should

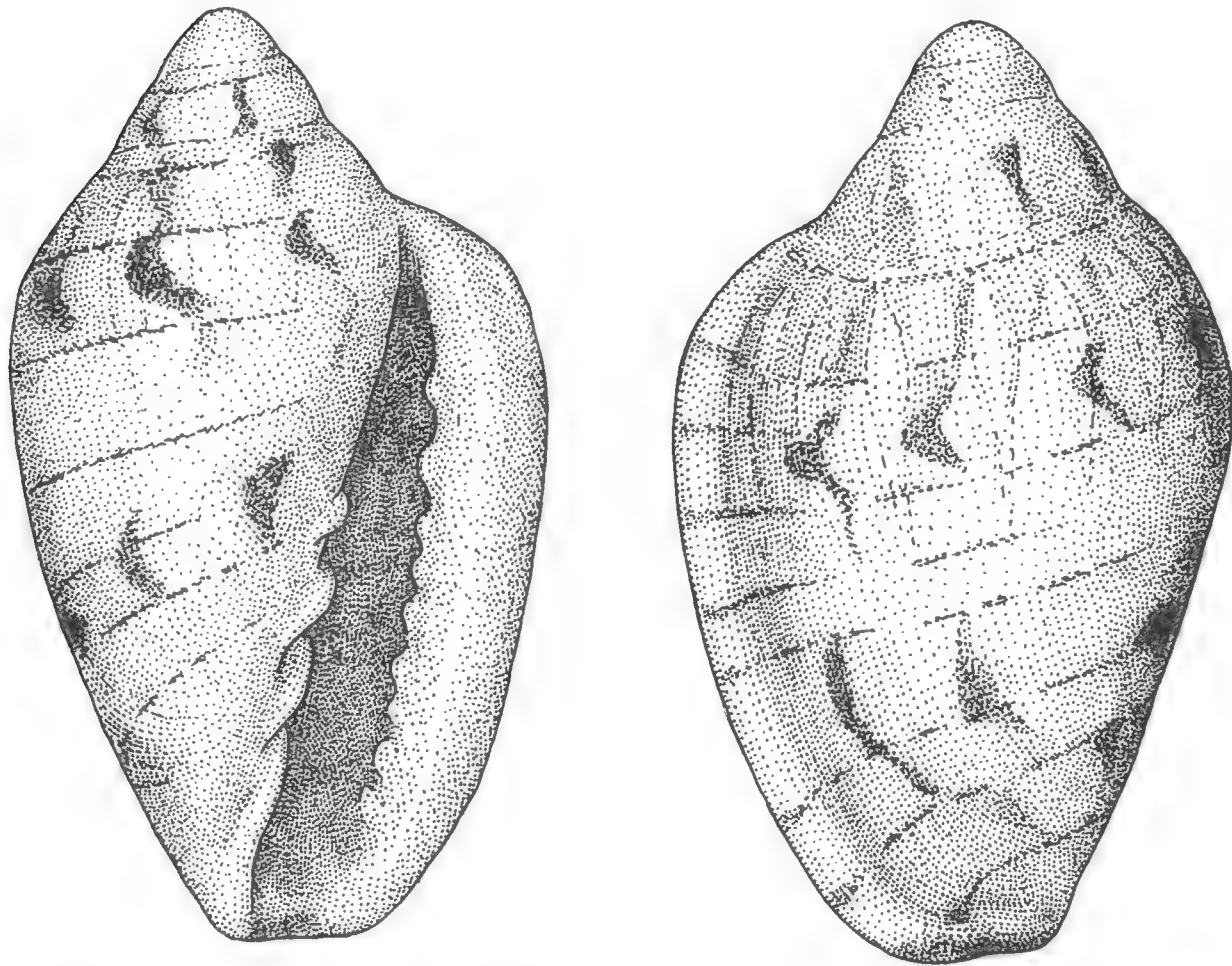


Fig. 12 a,b. *Marginella eveleighi* Tomlin and Shackleford: holotype, São Tomé island (NMW, no. 1955-158-1091). Actual size 6.2 mm.

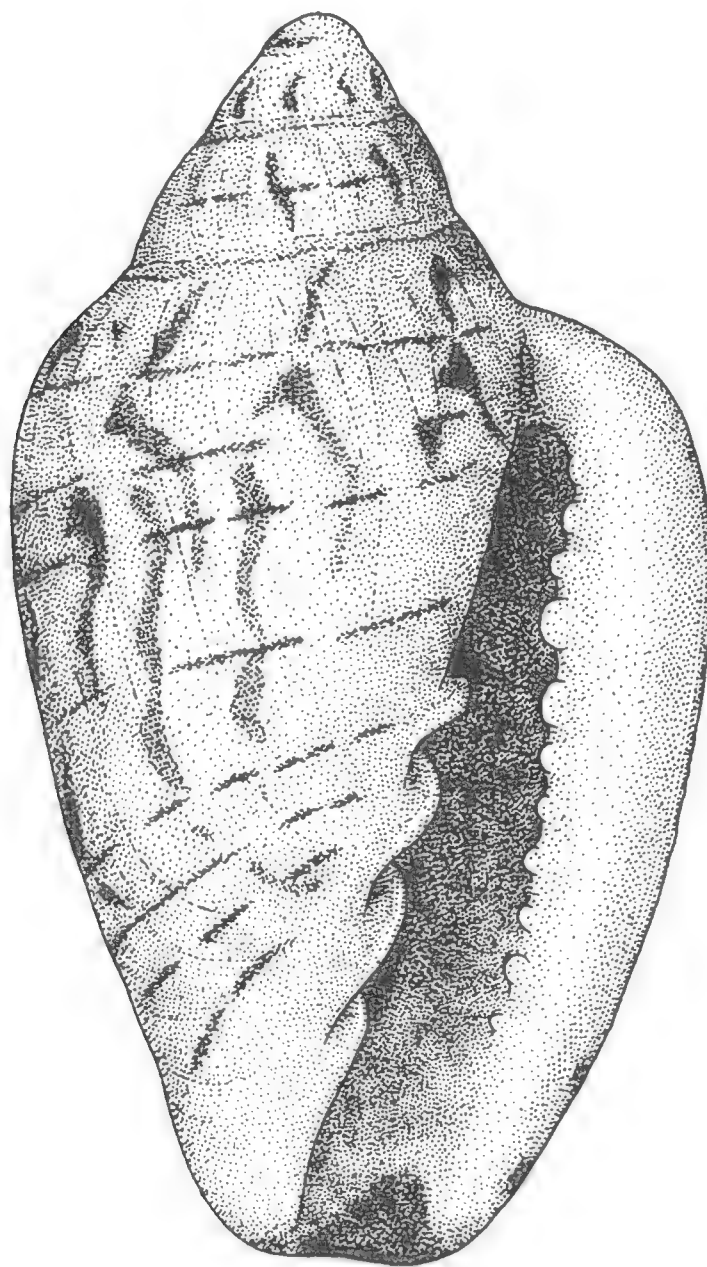


Fig. 13. *Marginella eveleighi* Tomlin and Shackleford: bay of Ana Chaves, São Tomé (Calypso 'Gulf of Guinea' cruise, MNHN) Actual size 8.3 mm.

be referred to a different species, unknown in the islands. *M. eveleighi* is reported by Knudsen (1950, 1956) in several Atlantide stations, between Liberia and Cameroon.

Marginella tyermani has its type locality in Corisco (Gabon) and the original description by Marrat (1876) does not show any essential difference with *M. eveleighi*. We do not preclude that it be a senior synonym, but prefer to use the name *eveleighi* for insular

specimens until identity is established by observing living animals from the mainland.

Habitat

The environment where *M. eveleighi* is found is very different from that of other species of the island. It is usually located near the mouth of small streams, in fine silty sand, loaded with plant debris of terrestrial origin. Our specimens have been collected with the hand dredge in 1–2 m depth.

Genus **Volvarina** Hinds, 1844

Type species: Marginella (Volvarina) nitida Hinds, 1844, subsequent designation by Redfield (1871); subjective synonym of *Voluta mitrella* Risso, 1826.

Shell 5 to 20 mm in length, oblong, often translucent with spiral bands. Spire small, low to moderately high, with rounded apex; the body whorl accounts for most of the length of the shell. Columella with four plaits in its anterior half. Outer lip thickened and always smooth inside. Siphonal canal not incised.

Head bifurcated, with slender tentacles and eyes in small bulges laterally to the base of the tentacles, as in *Marginella*. Siphon large and protruding over the head.

Foot crawling flat on the substrate, very large, longer than the shell when extended, tapering posteriorly.

Mantle expanding completely over the shell when the animal is moving, pustulose on outer surface. When outer mantle is retracted, part of inner mantle can usually be seen through the shell.

Remarks

We will here follow the opinion of Coan and Roth (1976), that *Volvarina* Hinds, 1844 and *Hyalina* Schumacher, 1817 should be held as distinct genera. Statements of *Marginella avena* Kiener, 1834 as type species are incorrect; Hinds' comment that '*M. avena* is a typical species' is not a designation under article 67 C (1,2) of the zoological code, and Redfield's (1871) designation of *M. nitida* is valid.

This genus contains many similar species which are not easily distinguished by the shell characters. The colour pattern on the foot, head and siphon is very helpful for taxonomy at specific level.

Volvarina insulana n. sp. (Figs. 14, 15; Pl. 1D)

Etymology: from Latin *insulana* (adjective), inhabitant of an island.

Type material: Holotype Fig. 14 and paratype Fig. 15: Esprainha (MNHN). Unfigured paratypes: same locality, numerous specimens (MNHN, NMW, IIT, FF); Praia Emilia, 10 specimens (MNHN, FF); South of town of São Tomé (FF); Sant'Ana (FF). Unfigured paratypes: São Tomé island (unspecified locality), numerous shells labelled *Marginella triticea* Lamarck (Tomlin collection, NMW).

Other material examined: Praia das Conchas, 8 shells (MNHN). Principe island: 2 shells labelled *Marginella simeri* (coll. Navel, 1920, MNHN); Ponta Linslager, Fernando Po island: 1 shell labelled *Marginella exilis* (purchase from R. E. Petit, 1972, probably collected by Hubert; MNHN).

Shell 6 to 11 mm in length (holotype: 6.8 mm), oblong elongate, with a small, moderately elevated spire, and body whorl making about 9/10 of total length. Outer lip smooth, thickened inside in its median portion, evenly outlined. Shell material translucent, tawny with three fading darker bands on the body whorl.

Foot translucent, with flecks of yellow and various tones of brown; the size of flecks decreases towards the edge. The propodium, and the axis of the metapodium are superficially stained with grey.

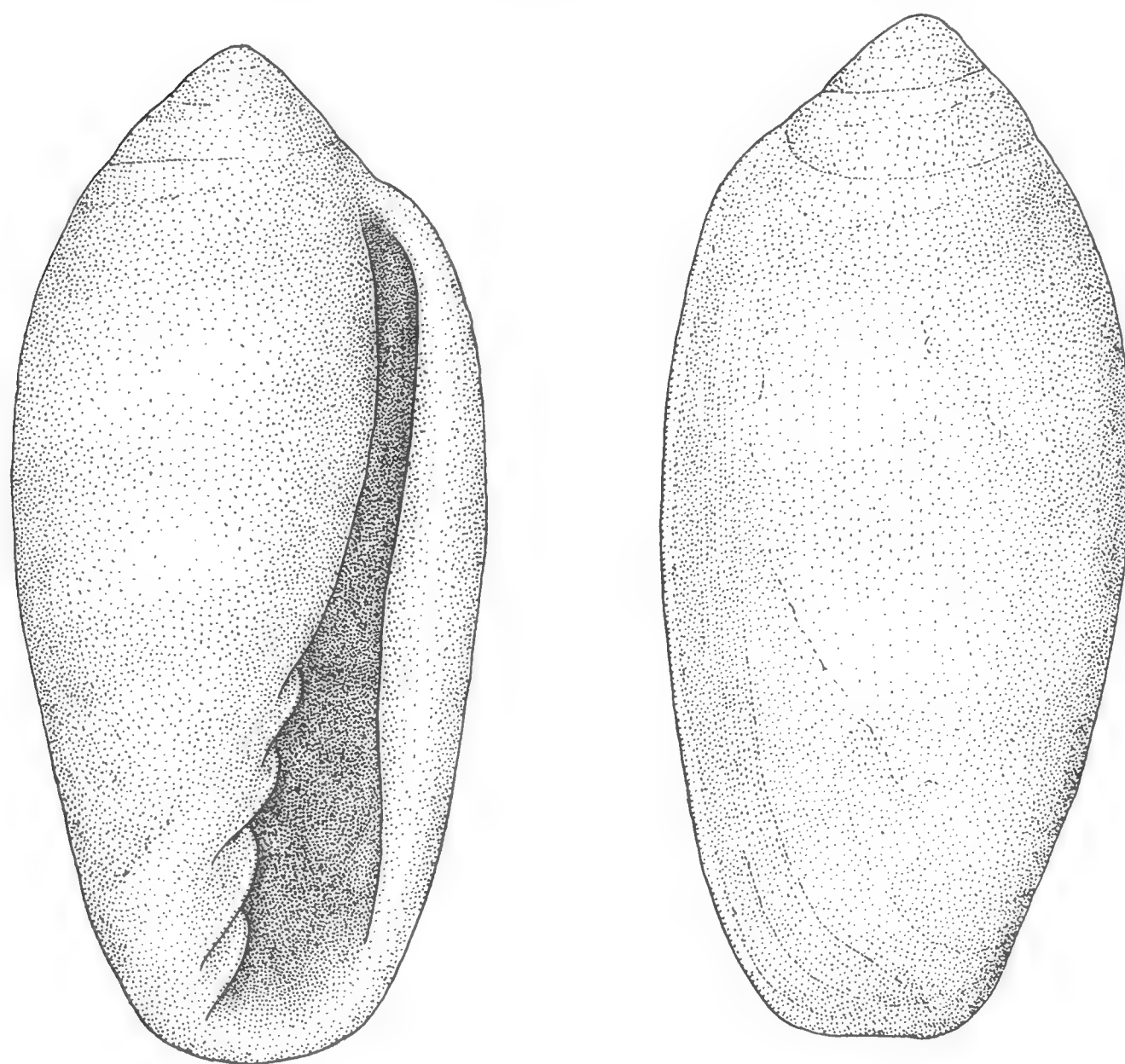


Fig. 14 a,b. *Volvarina insulana* n. sp.: holotype, Esprainha 3–5 m. Actual size 6·8 mm.

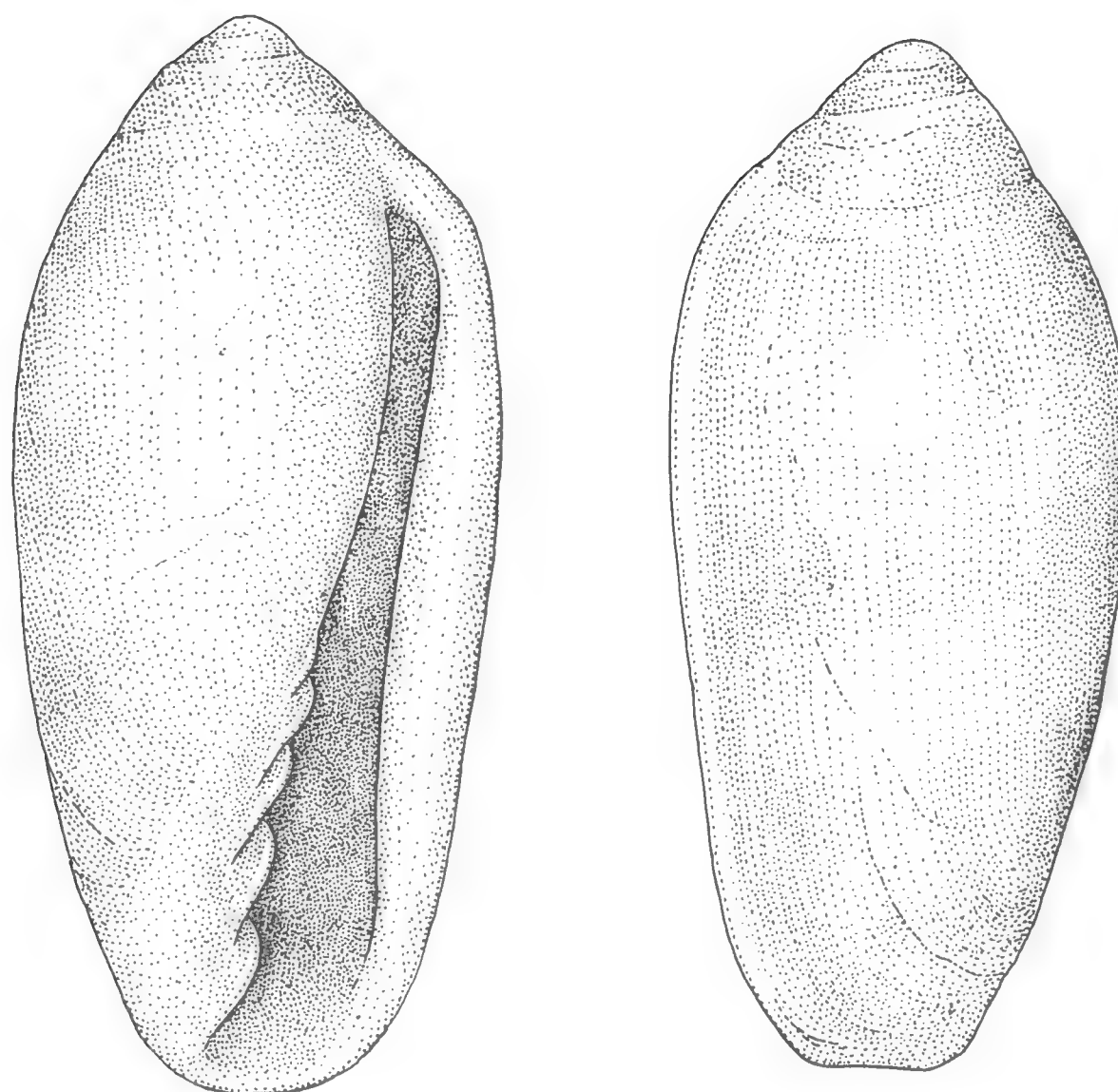


Fig. 15 a,b. *Volvarina insulana* n. sp.: paratype, same locality. Actual size 6·2 mm.

Tentacles translucent, with small rusty brown and yellow flecks. The area behind the eyes is stained with black. Siphon dark brown with pale yellow spots.

The part of mantle that extends over the shell is marbled with various tones of brown, and covered with yellow pustules. The edge of the mantle is articulated with a cream and dark brown border. Internal mantle with yellow spots can be seen through the shell.

Remarks

The shell of this species resembles most *Volvarina exilis* (Gmelin, 1790). The latter is distinguished by the outline of the outer lip, swollen posteriorly whereas *V. insulana* n. sp. is quite regularly fusiform. *V. ambigua* (Bavay in Dautzenberg, 1912), from Rio de Oro, is similar but larger with a lower spire.

A thorough comparison with species from the mainland will only be possible when all living animals are known. There are several species of *Volvarina* on the Angolan coast, all of them with a different polychromatism of the soft parts (e.g. orange spots on siphon and foot).

Tomlin and Shackleford (1914) have mentioned this species as *Marginella triticea* Lamarck. They have named for São Tomé a variety *alba* (infrasubspecific name, anyway preoccupied by *Marginella alba* C. B. Adams, 1850 among others).

We have seen some shells from the islands of Fernando Po and Príncipe, which do not seem different from the São Tomé species. However, we did not include them in the type material, as only observation of the living animals can prove if they are conspecific.

Habitat

On rocks embedded in sand and covered with finely agglutinated sediment, in 2–5 m depth; usually at the border of rocky areas next to soft bottoms.

Genus **Granulina** Jousseaume, 1888

Type species: *Marginella isseli* Nevill et Nevill, 1875 (replacement name for *M. pygmaea* Issel, 1869, non Sowerby, 1846), by monotypy.

Shell 1.8 to 3 mm in length, globose, with the spire entirely concealed by the large body whorl. Columella with four plaits in its anterior half. Outer lip heavily thickened, inrolled and distinctly denticulated internally. Siphonal canal not deeply incised. Shell always porcellaneous white.

Head bifurcated, with slender tentacles and eyes in small bulges laterally at their base, as in *Marginella*. Siphon large, elongate, protruding over the head.

Foot very large, crawling flat on the substrate, almost twice as long as the shell when fully extended.

Mantle extending over the shell to cover it completely, as in the Cypraeaacea. The outer surface is pustulous, generally coloured. When the outer mantle is retracted, an inner mantle, colourless or with pale spots may be seen through the shell.

Radula is present (Fig. 16). Each side of central tooth is bristled with 4–5 stout, pointed cusps; an axial cusp, often unevenly divided, is slightly larger, more appressed and fits in a furrow of the next tooth.

Granulina parilis n. sp. (Figs. 17, 18; Pl. 2C)

Etymology: from Latin *parilis* (adjective), similar (allusion to poorly diagnostic shell)

Type: Holotype Fig. 17 and paratype Fig. 18: Esprainha (MNHN). Unfigured paratypes: Esprainha, numerous specimens (MNHN, IIT, NMW, FF). Mutamba, 2 specimens (MNHN). Praia das Conchas, shells (MNHN). Praia Emilia, 2 specimens (FF).

Shell 1.8 to 2.0 mm in length (holotype: 1.95 mm), with characteristics of the genus. Outer lip with some 20 denticles in the inner edge. Body whorl rather translucent, with its

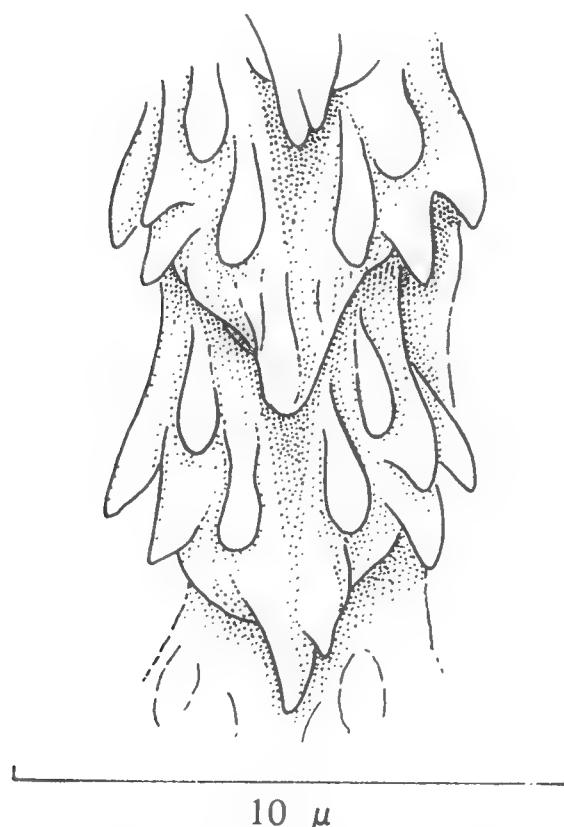


Fig. 16. *Granulina parilis* n. sp.: two rows of the radula. Specimen from Esprainha. Scale bar is 10 μ m.

greater diameter closer to posterior end of shell. The anterior part of the shell is rather tapering, with a slight break in the outline towards the anterior one-third.

Foot and siphon translucent, with irregular clusters of yellow flecks and few sparse orange spots. There are two bright orange markings at the base of the tentacles, next to the eyes, and a series of yellow spots (occasionally, an orange spot) on the anterior two-thirds of the tentacles.

External mantle black, with large yellow pustules, dense and evenly distributed tiny yellow dots, scattered orange dots and two or three bright turquoise spots. Internal mantle can be seen through the shell, whitish with pale orange spots.

Remarks

The shell of this species resembles *G. occulta* (Monterosato, 1869), but neither that nor any other Mediterranean species have the orange markings on the foot and tentacles. The shell of Brazilian species *G. clandestinella* (Bavay, 1907) differs by a more evenly rounded outline, with greatest diameter about half length of the shell.

Habitat

In the dense algal mat of rocky bottoms, in 3–5 m depth, together with '*Cystiscus*' *gutta*, *Marginella spinacia*, *Gibberula punctillum*.

Genus **Cystiscus** Stimpson, 1865, *sensu* Roth and Coan (1968)

Remarks

The generic classification of the following species as *Cystiscus* is only provisional. Our new species is congeneric with '*Cystiscus*' *jewettii* (Carpenter, 1857), '*Cystiscus*' *politulus* (Dall, 1919) and '*Cystiscus*' *larva* (Bavay, 1922), assigned to *Cystiscus* by American authors following a lead by Roth and Coan (1968).

The type species of *Cystiscus*, *Marginella cystiscus* Redfield, 1870 (replacement name for *Cystiscus capensis* Stimpson, 1865, a secondary homonym of *Marginella capensis* Krauss, 1848) has been described and figured by Stimpson (1865); it has a flattened head, with two short triangular tentacles and no visible siphon. These characters are very different from those of our species, as well as from '*Cystiscus*' *jewettii* figured by Roth and Coan (1968) p. 66. As a

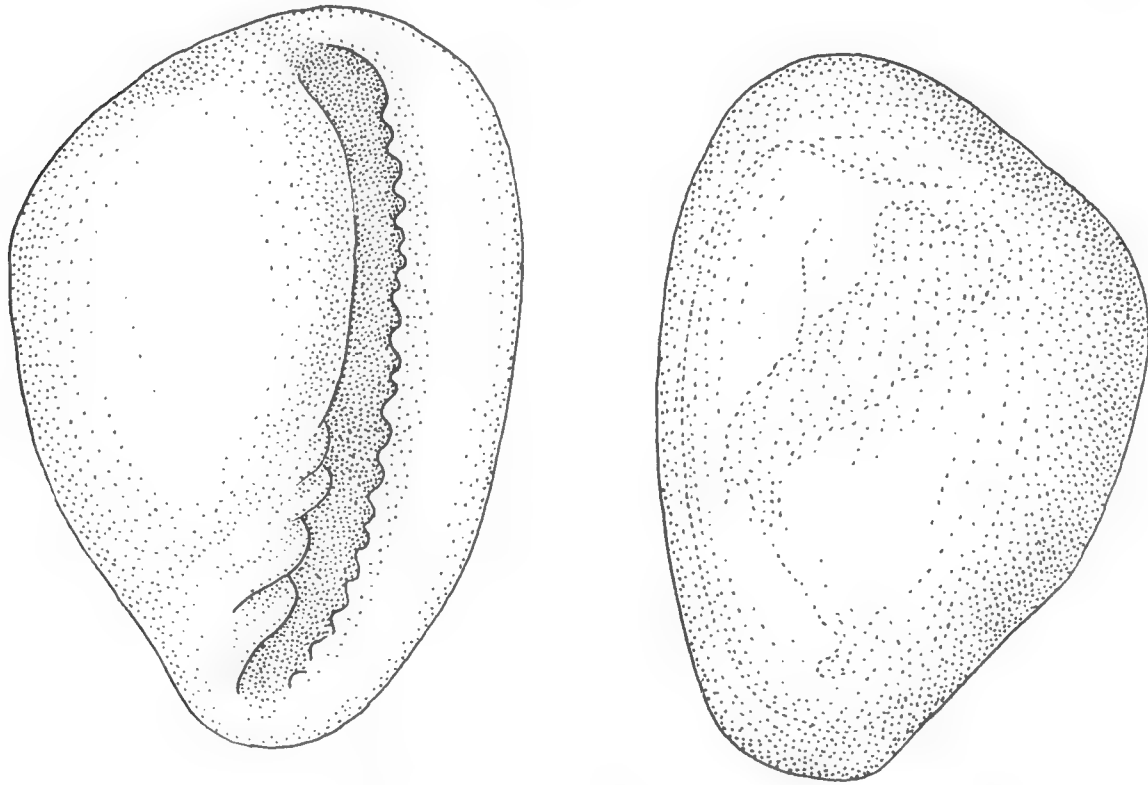


Fig. 17 a,b. *Granulina parilis* n. sp.: holotype, Esprainha 3–5 m. Actual size 1.95 mm.

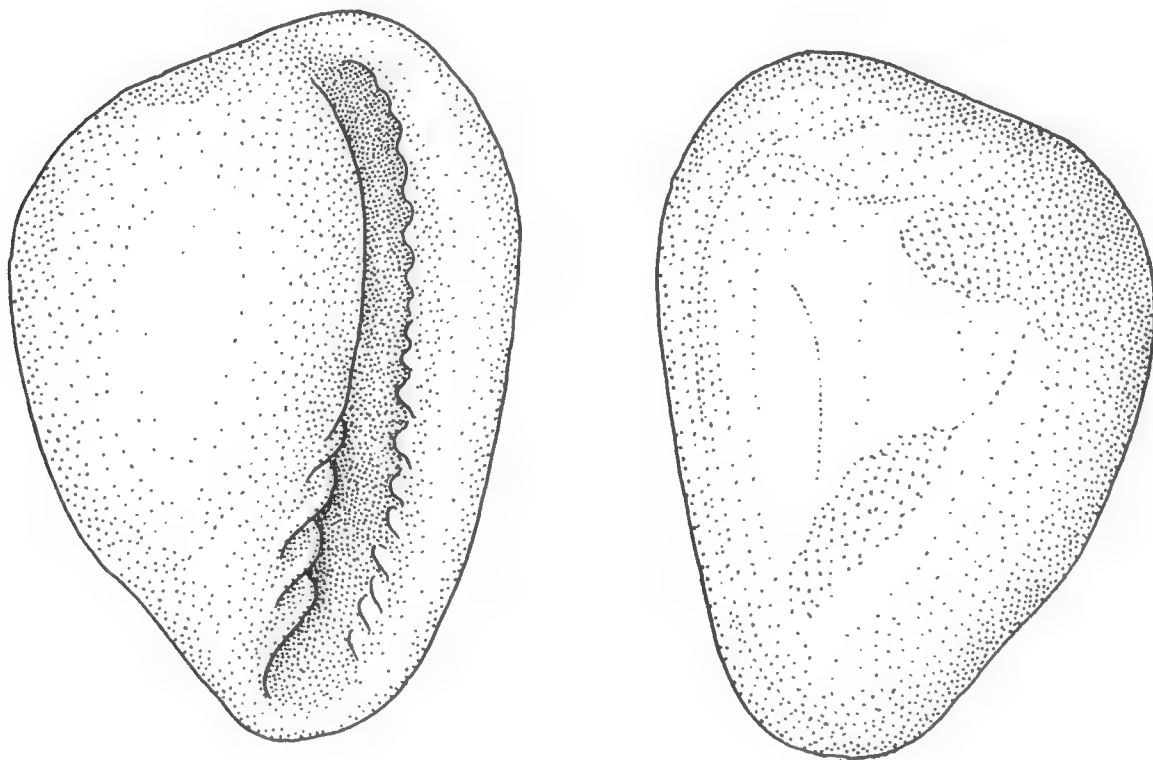


Fig. 18 a,b. *Granulina parilis* n. sp.: paratype, same locality. Actual size 1.9 mm.

solution to this taxonomic problem remains beyond the scope of this paper, we shall follow the current, though certainly incorrect, acceptance of *Cystiscus*.

‘*Cystiscus*’ *gutta* n. sp. (Figs. 19, 20; Pl. 2A)

Etymology: from Latin *gutta*, *ae*, n.f.: drop of water (shape of the shell)

Type material: Holotype Fig. 19 and paratype Fig. 20: Esprainha, collected alive (MNHN). Unfigured paratypes: same locality, numerous specimens (MNHN, IIT, NMW, FF); Mutamba, 3 specimens (MNHN).

Shell 2.5 to 2.6 mm in length (holotype: 2.6 mm), oblong, swollen posteriorly, with low, very globose spire. Outer lip thickened and curled in, smooth internally. Columella with three or four very weak plaits, hardly exceeding the anterior one-third of the aperture. Shell material hyaline, white, clearly showing the internal suture and soft parts.

Head bifurcated, translucent, with two cylindrical, elongate tentacles; the eyes are located in small bulges next to the base of the tentacles. Siphon large, somewhat widening anteriorly, coloured with dense yellow and brown blotches.

Foot translucent, crawling flat on the substrate, with yellow and brown blotches increasing in size towards posterior end.

Internal mantle conspicuous through the shell, dark green with a brownish median area, covered with pale yellow flecks; there are two spiral series of larger pale yellow spots

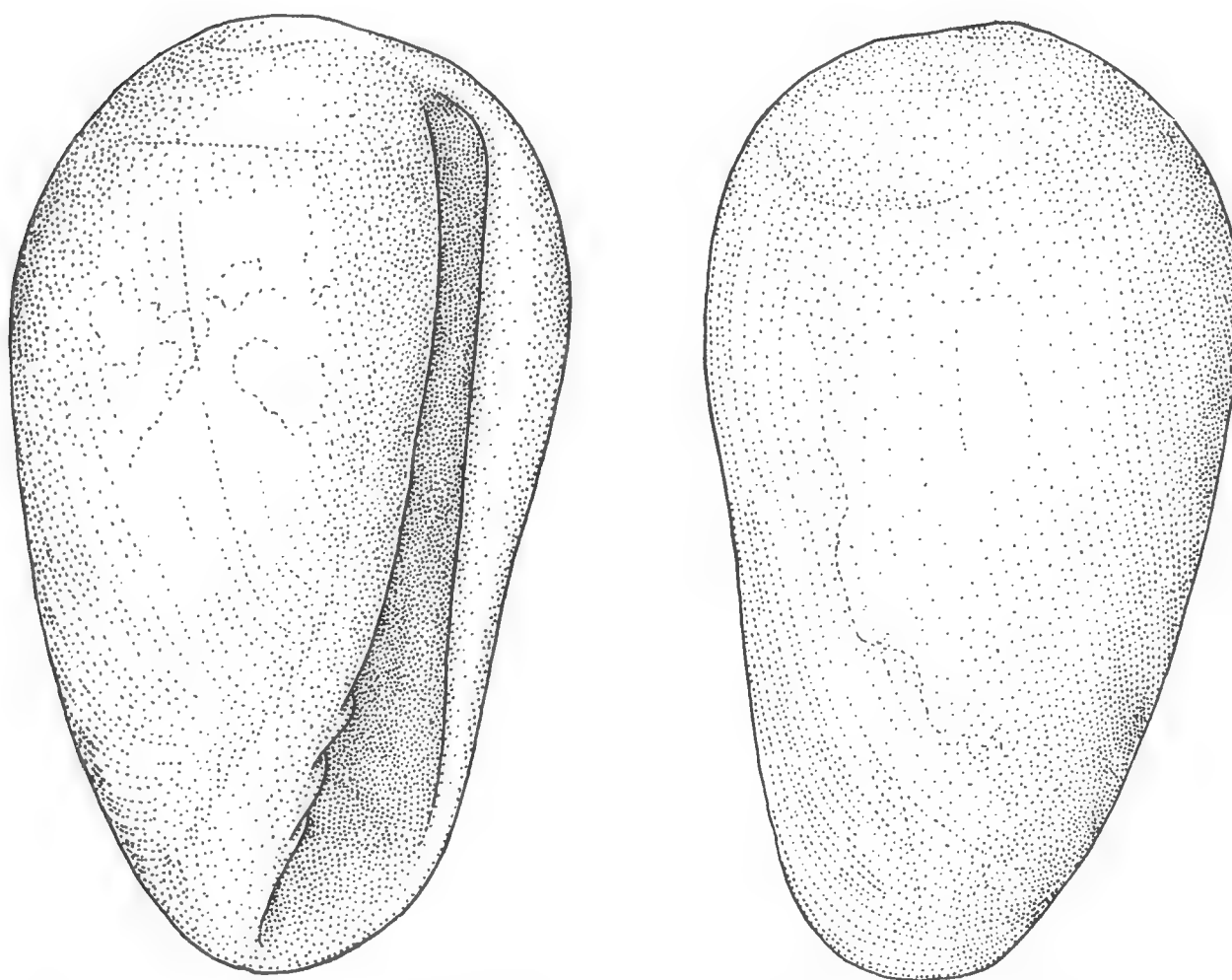


Fig. 19 a,b. '*Cystiscus*' *gutta* n. sp.: holotype, Esprainha 3–5 m (MNHN) Actual size 2.5 mm.

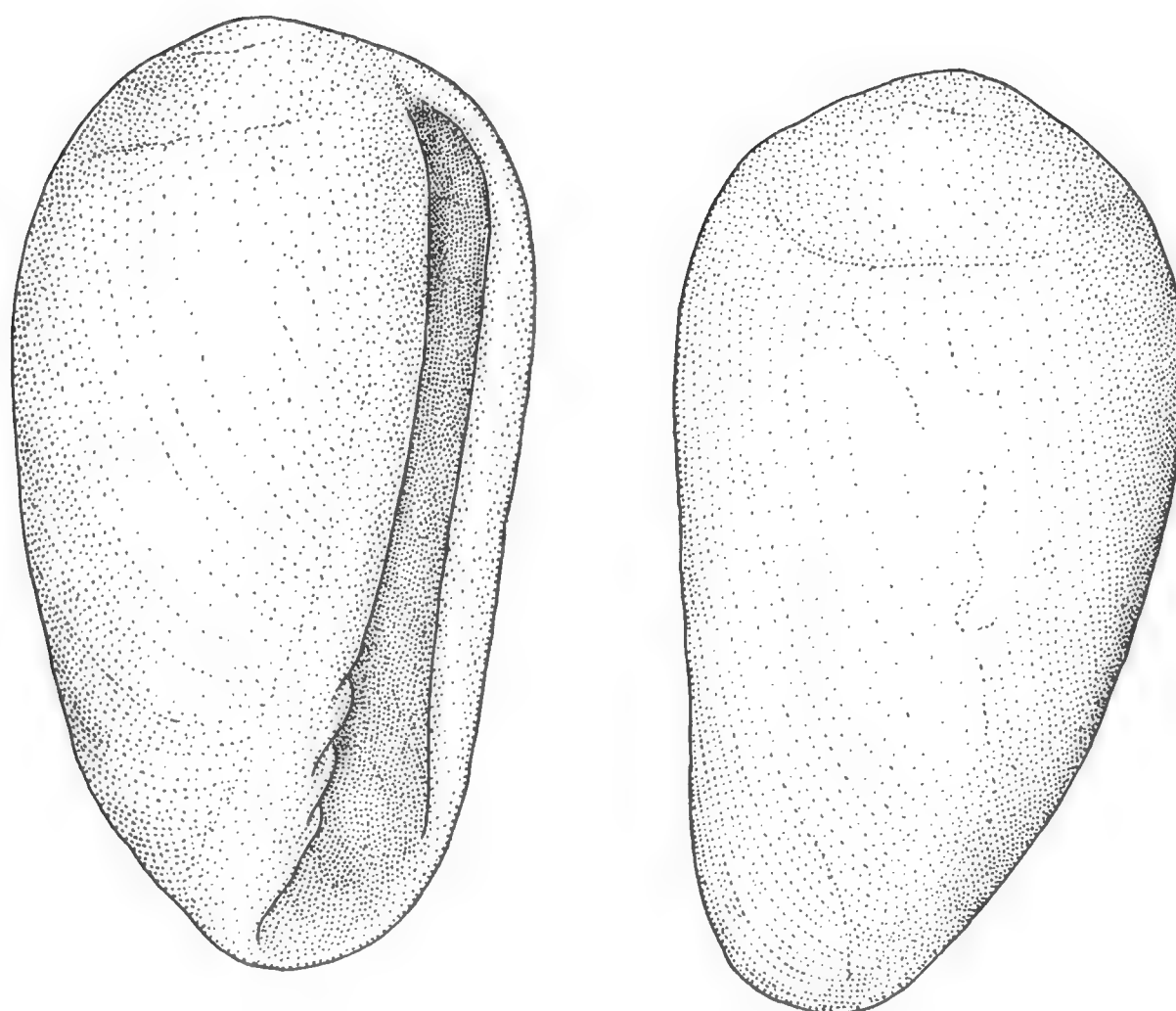


Fig. 20 a,b. '*Cystiscus*' *gutta* n. sp.: paratype, same locality. Different aspect of the outer lip is due to slightly different orientation of this specimen, rotated to the right.

with small orange dots. The external mantle is translucent and hardly visible when it extends over the shell.

Remarks

This species is congeneric, according to shell characters, with '*Marginella*' *consanguinea* Smith, 1890, of Santa Helena island. The latter is readily distinguished by its obtuse conical, not rounded spire.

There is also a congeneric species in Cape Verde islands (personal communication from D. Moreno, Madrid).

Habitat

Infralittoral, in the dense algal mat of rocky bottoms around Esprainha, in 3–5 m depth, together with other species described herein.

Genus **Persicula** Schumacher, 1817

Type species: Persicula variabilis Schumacher, 1817, by monotypy (a replacement name for *Voluta persicula* Linné, 1758)

Shell 5 to 30 mm in length, ovoid, rather stout, with a very low spire almost concealed by the body whorl. Columella with four or more plaits, decreasing in size towards posterior end. Outer lip thickened internally and bordered externally, with denticles that are continued as raised lines inside the aperture. Siphonal canal distinctly notched. Colour pattern with various designs of spots, wavy lines or bands.

Head divided, with a separation reaching deeply behind the eyes, bearing two short tentacles and two small anterior lobules. The eyes are a short distance behind the insertion of the tentacles, somewhat laterally but not protruding. Siphon rather short, its base often bordered with a small pad.

Foot hardly longer than the shell when fully extended, broadly rounded posteriorly. The mantle extends little over the shell when the animal is crawling; some designs on the internal mantle may be seen through the shell on the smaller species.

Radula is present. That of *P. thomensis* has crowded, arcuate central teeth with a larger, depressed axial cusp and laterally a series of 4–5 pointed cusps. The axial cusp of each tooth fits in a definite furrow of the next one. There is appreciable variation in the morphology of the teeth along the same radula (Fig. 21).

Persicula thomensis (Tomlin, 1918) (Figs. 22, 23; Pl. 1E)

Original reference: *Marginella dautzenbergi* Tomlin and Shackleford, 1912, p. 319, Pl. 4, figs. 1–2 (non *Marginella dautzenbergi* (Cossmann, 1896). *Marginella thomensis* Tomlin, 1918, p. 65 (replacement name).

Type material: Holotype in BMNH.

Other material examined: Esprainha, numerous specimens (MNHN, IIT, FF). Praia das Conchas, 20 specimens (MNHN, FF). South of the town of São Tomé: 50 specimens. São Tomé island (unspecified locality): 3 shells (purchased Preston, MNHN). Santo Antonio, Principe island: 2 shells (Calypso cruise 'Gulf of Guinea' st. P 22, MNHN). Principe island: 6 shells (coll. Navel, MNHN).

Shell 6.5 to 7 mm in length, with the spire almost concealed by posterior insertion of outer lip. Columella with about ten plaits, the five foremost definite, the remainder gradually decreasing in size. Outer lip distinctly denticulated. Shell material translucent, tawny with six spiral series of elongate to crescent-shaped brown markings (of which three may be more developed).

The external suture is underlined by a dark brown line; there is a brown blotch in the siphonal canal and others on the outer lip.

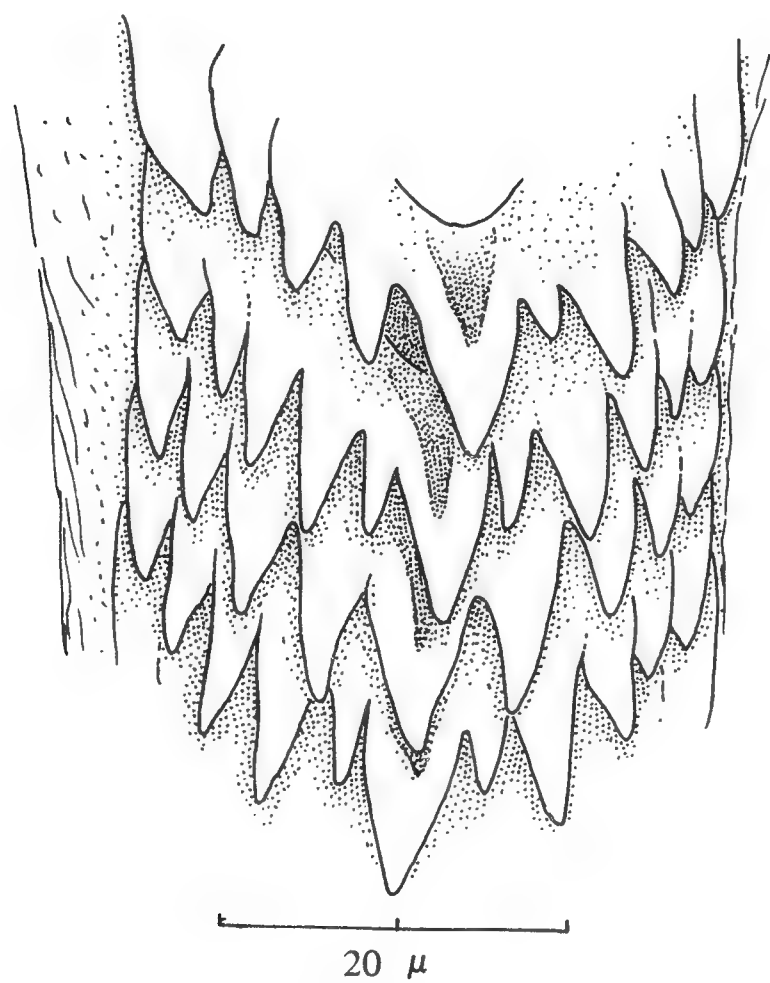


Fig. 21. *Persicula thomensis* Tomlin: four rows of the radula; note difference between teeth. Specimen from Esprinha. Scale bar is 20 μ .

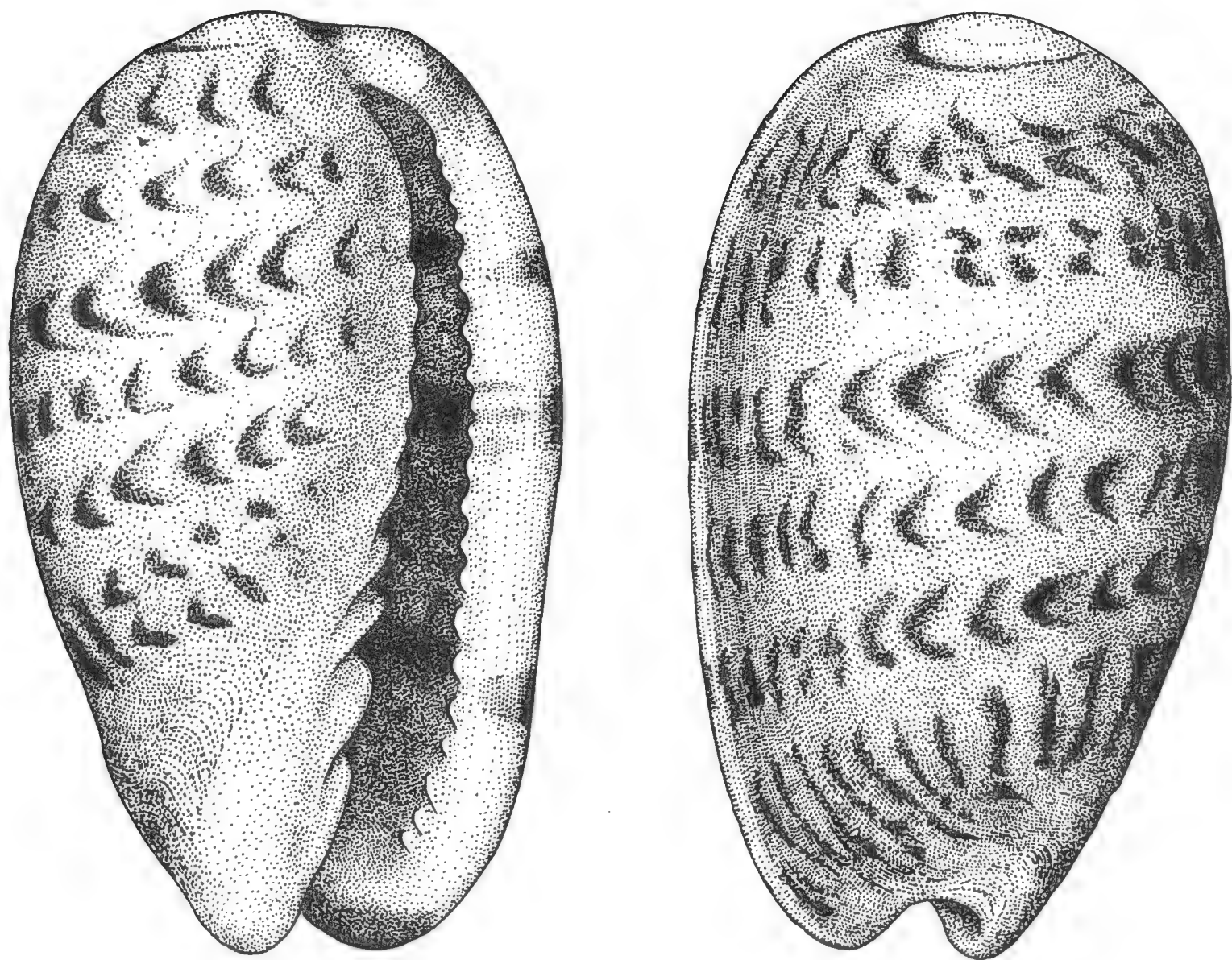


Fig. 22 a,b. *Persicula thomensis* Tomlin: Esprinha 3–5 m. Actual size 6.7 mm.

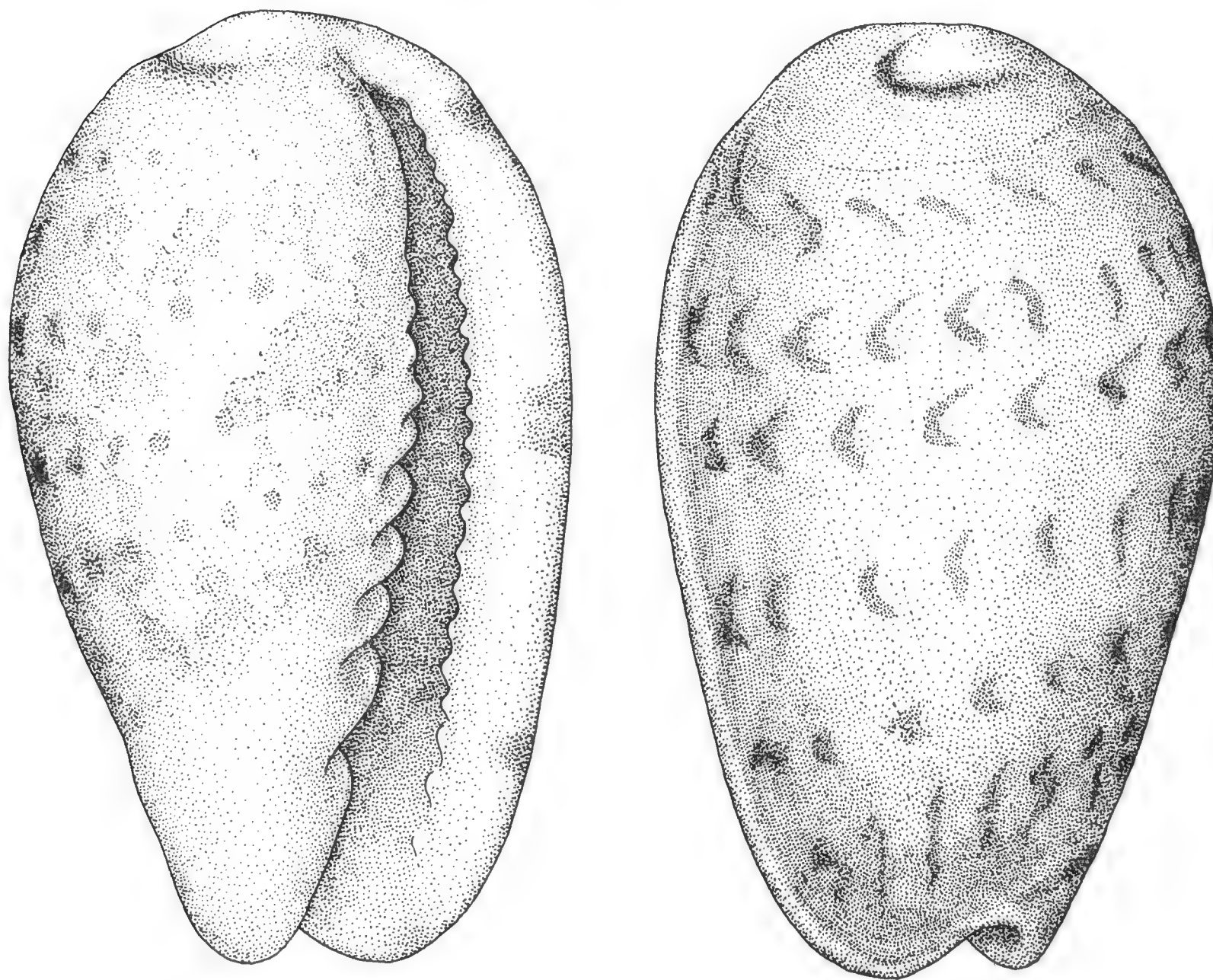


Fig. 23 a,b. *Persicula thomensis* Tomlin: Praia das Conchas 1–2 m. Actual size 7.0 mm.

Head, siphon and foot with evenly distributed yellow (dominant), blackish and orange blotches. The internal mantle may be seen through the shell, with irregular pale areas on a dark background.

Remarks

We have noticed a geographic variation in this species, between our localities of São Tomé: At Esprainha (Fig. 22) and Mutamba, the shell is narrower, more intensely coloured with crescentic spots tending to become confluent longitudinally. The density of colour patches on the foot is higher, with higher proportion of black. The internal mantle is almost entirely dark, with only few pale spots.

At Praia das Conchas (Fig. 23) and south of São Tomé, the shell is slightly larger, translucent with reduced markings. The foot has few black spots and the internal mantle is mostly pale with some dark areas.

This trend is similar to that found in *Marginella spinacia* n. sp., where the population from Esprainha is also darker and smaller than at Praia das Conchas.

The shells from Principe we have seen are not very different from those of Praia das Conchas.

This species is related to some Caribbean species, e.g. *P. frumentum* (Sowerby, 1831), rather than to any West African species. It is also similar to *P. pulchella* (Kiener, 1841), a species described originally from 'Nouvelle Hollande' (Australia). We have examined a photograph of the syntypes (MHNG no. 1152/64, kindly communicated by Y. Finet) and noted that *P. pulchella* differs by a more truncated spire, and the spiral series of markings distinctly confluent longitudinally to build wavy lines.

The reference for São Tomé of the Mediterranean species *Gibberula miliaria* (Linné) by Nobre (1909) is erroneous and probably based on a bleached specimen of *P. thomensis*.

Habitat

Infralittoral hard bottoms with dense algal mat, also in fissures between stones and under stones with sediment deposits, together with *Marginella spinacia* n. sp.

Genus **Gibberula** Swainson, 1840

Type species: Gibberula zonata Swainson, by monotypy. This is an objective synonym of *Marginella oryza* Lamarck, 1822).

Shell 1.5 to 10 mm in length, ovoid, stout, with a low spire. Outer lip thickened, commonly denticulated. Columella with several plaits, decreasing in size towards its posterior end. Siphonal canal distinctly notched. Shell material translucent, particularly in the smaller species, colourless or with spiral bands.

Head divided, with a separation reaching deeply behind the eyes, bearing two short tentacles and two small anterior lobules. The eyes are a short distance behind the insertion of the tentacles, somewhat laterally but not protruding. Siphon short, its base often bordered by a small pad.

Foot slightly longer than the shell when the animal is crawling. According to the particular species, it may crawl flat on the substrate or raised laterally in parapodia.

Mantle extending very little on the outer surface of the shell. The internal mantle is clearly seen through the shell and underlines the internal sutures.

Remarks

The distinction between *Gibberula* and *Persicula* appears very tenuous, except for size. The distinctive characters of *Persicula* are in the outer lip, bordered externally and extending over the spire, and a more diverse colour pattern of the shell.

The radula is present in the species we know. There is a large, depressed central cusp fitting in a depression of the next tooth, and a variable number of cusps laterally to it. The lateral cusps are few and rapidly decreasing in size, not comb like as in *Persicula*. The tooth morphology is not very stable along the same radula (Fig. 24).

The character of the foot, raised in parapodia in some species, may not be significant for definition of genera. The foot crawls flat in *G. oryza* (type species) and raises definitely in parapodia in *G. secreta* Monterosato, 1889 which is closely related.

Gibberula modica n. sp. (Fig. 25; Pl. 2D)

Etymology: from Latin *modicus*, a, um (adjective): mean.

Type material: Holotype (MNHN) and 5 unfigured paratypes (FF): Esprainha, collected alive.

Other material examined: Praia das Conchas, 1 shell (MNHN)

Shell up to 3.5 mm in length (Holotype: 3.3 mm), ovoid, with a very low spire. Columella with five massive plaits, decreasing in size posteriorly. Outer lip arched, thickened, with some 20 thick denticles on the inner side; its posterior insertion is slightly protruding. Shell material white, translucent.

Head bearing two cylindrical tentacles and two conspicuous anterior lobules. Eyes laterally behind the insertion of the tentacles, surrounded on the inner side by a large brown area; there are some yellow and brown spots on the tentacles.

Internal mantle clearly seen through the shell, with irregular dark brown areas on a pale background, and evenly distributed orange spots. This pattern continues on the siphon. Foot rather broad, crawling flat, with alternating clusters of brown spots and pale yellow areas; occasionally an orange spot.

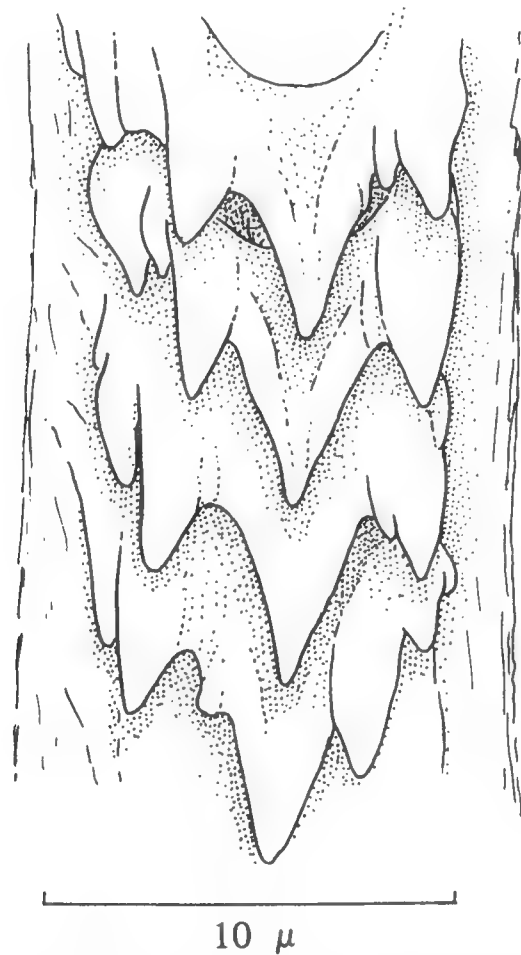


Fig. 24. *Gibberula cucullata* n. sp.: four rows of the radula. Specimen from Esprainha. Scale bar is 10 μ m.

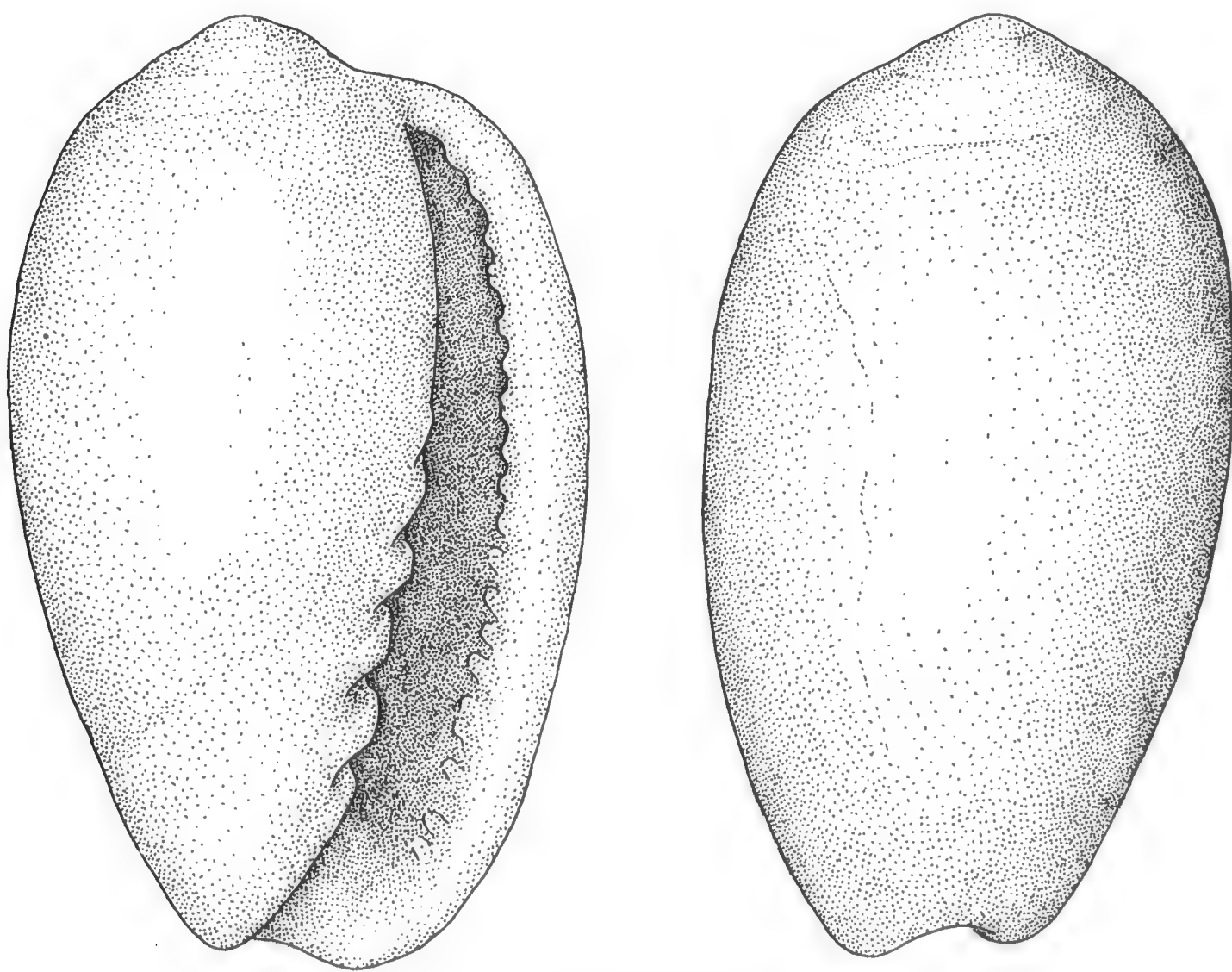


Fig. 25 a,b. *Gibberula modica* n. sp.: holotype, Esprainha 3–5 m. Actual size 3.3 mm.

Remarks

The colour pattern of the foot (but not of the mantle) is similar to that of the Angolan species *Gibberula pallata* (Bavay in Dautzenberg, 1913). The latter is larger, its shell is more swollen with usually a spiral band.

Habitat

This species has been found in 3–5 m depth, on a surface of soft bottom (fine grained silty sand) facing the mouth of a small stream.

Gibberula punctillum n. sp. (Figs. 26, 27; Pl. 2E,F)

Etymology: from Latin *punctillum*, n.m.: small dot (allusive to small size of this species)

Type material: Holotype and figured paratype: Esprinha, collected alive (MNHN). Unfigured paratypes: same locality, numerous specimens (MNHN, IIT, NMW, SAM, UAN, FF). Mutamba, numerous specimens (MNHN, FF); Praia das Conchas, 10 shells (MNHN).

Shell 1.8 to 1.9 mm in length (holotype: 1.9 mm), ovoid, with a low but conspicuous spire. There is a slight break in the outline next to the anterior end, which is rather tapering. Outer lip thickened, tapering anteriorly, with some 15 denticles on the inner side. Shell material hyaline, colourless.

Head bearing two small, stout cylindrical tentacles and two small anterior lobules. There is generally a brown area in front of the eyes, and some yellow, brown and orange spots on other parts of the head.

Internal mantle clearly seen through the shell, dark with irregular pale yellow areas, sprinkled with green and orange dots. There are large plain white areas on the inner mantle of some specimens. A small lobe of outer mantle, almost colourless, has been seen on the left side. Siphon short, yellow and brown.

Foot crawling flat, with alternating brown and yellow areas, and small orange spots.

Remarks

Tomlin and Shackleford (1914) possibly referred to this species with the incorrect name of *Marginella philippii* Monterosato, 1878. The Mediterranean species is larger, its shell is not bevelled anteriorly and the polychromatism of soft parts is different. The two species are nevertheless closely related. The unusual character of large opaque white areas on the mantle is also found in *G. philippii*.

The shell of *G. punctillum* n. sp. resembles two undescribed species from southern Angola, but these are readily recognized by colour patterns of the mantle.

Habitat

In dense algal mat in 3–5 m depth, with other species previously described.

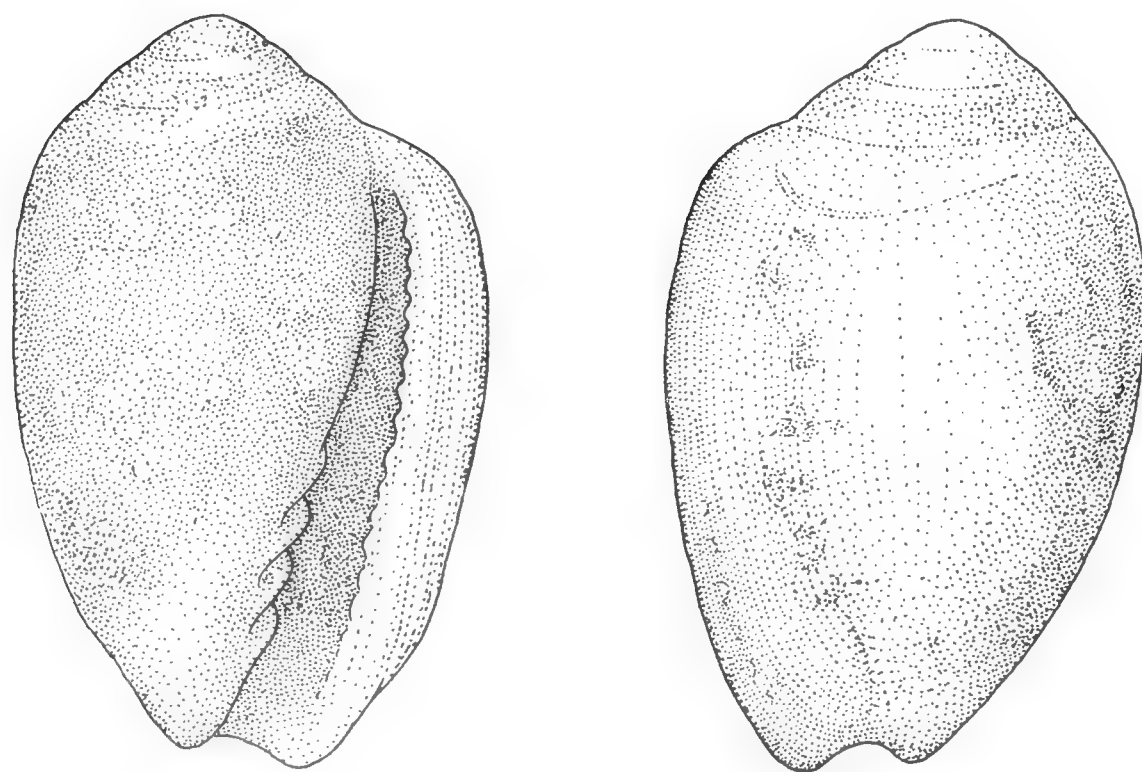


Fig. 26 a,b. *Gibberula punctillum* n. sp.: holotype, Esprinha 3–5 m. Actual size 1.9 mm.

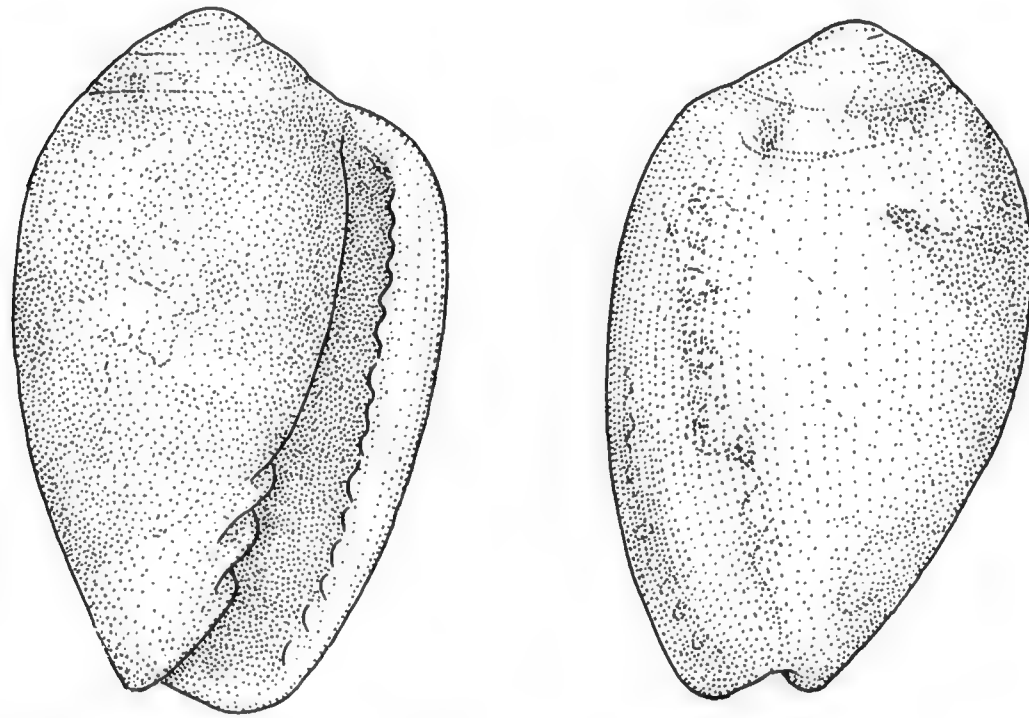


Fig. 27 a,b. *Gibberula punctillum* n. sp.: paratype, same locality. Actual size 1.8 mm.

***Gibberula cucullata* n. sp.** (Figs. 28, 29; Pl. 2B)

Etymology: from Latin *cucullatus*, *a, um*: wearing a cowl (allusive to the mask designed by the colour pattern on the head).

Type material: Holotype and figured paratype: Esprainha, collected alive (MNHN). Unfigured paratypes: same locality, numerous specimens (MNHN, IIT, NMW, FF).

Shell 2.5 to 2.6 mm in length (holotype: 2.6 mm), oblong ovoid, with rather prominent spire. Columella with four plaits, decreasing in size posteriorly. Outer lip thickened, with some 15 denticles internally, slightly protruding on outline posteriorly. Aperture becoming narrower posteriorly, continued by a channel at posterior insertion of the outer lip. Shell material translucent, of horny colour; the hue is more intense in the siphonal canal and the posterior insertion of the outer lip.

Head bifurcated, each part regularly tapering with conical tentacles, at first appressed, then forward divergent. The anterior lobules usual in the genus cannot be seen. The eyes are approximately in the axis of each tentacle. The entire head is black, except for a paler brown area around each eye.

The inner mantle is clearly seen through the shell, marbled of pale areas on a brown background, with occasionally some rusty spots. Siphon black externally, colourless internally, enveloping the siphonal canal area. There is also a small black lobe of mantle protruding through the channel at the posterior end of the aperture.

Foot translucent, with only some small opaque white spots, conspicuously raised in parapodia when the animal is crawling.

Remarks

This species is so different from other *Gibberula* by the morphology of head and foot, that it may deserve separate generic status. Many generic names, not separable conchologically from *Gibberula*, are available (e.g. *Granula* Jousseaume, 1875 with type species *Marginella bensoni* Reeve, from South Africa) but a decision could be made only with living specimens of the type species.

Such characteristic parapodia are also found in the Angolan species *Gibberula gruveli* (Bavay in Dautzenberg, 1913) but the morphology of head and siphon in the latter agrees better with general description of *Gibberula*.

The shell of *Gibberula cucullata* n. sp. resembles somehow the angolan species *G. columnella* (Bavay in Dautzenberg, 1913), which differs by a lower spire, the head with cylindrical tentacles and well developed anterior lobules, and the brightly coloured foot crawling flat.

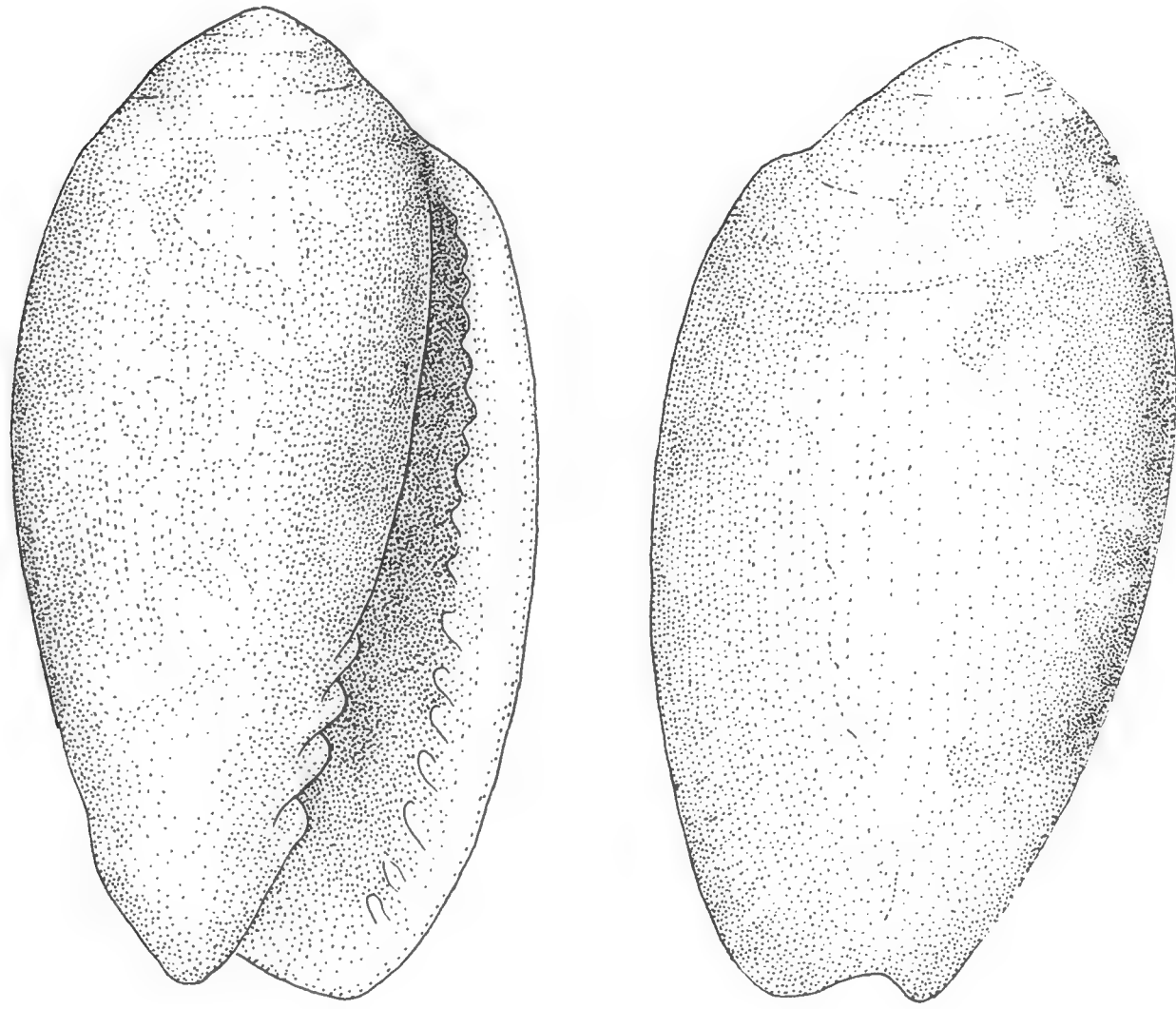


Fig. 28 a,b. *Gibberula cucullata* n. sp.: holotype, Esprainha 3–5 m. Actual size 2·6 mm.

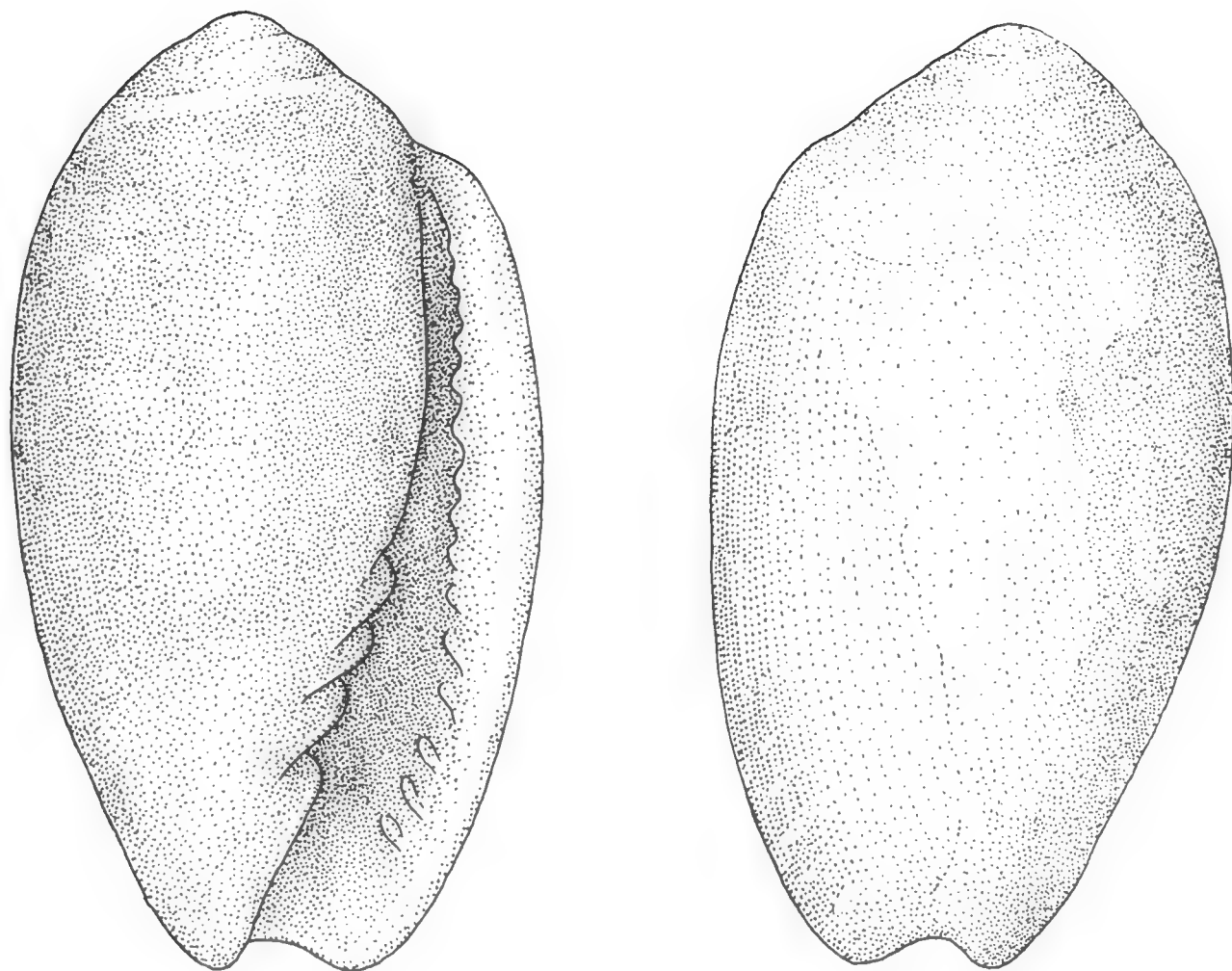


Fig. 29 a,b. *Gibberula cucullata* n. sp.: paratype, same locality. Actual size 2·5 mm.

Habitat

Infralittoral hard bottoms 3–5 m in dense algal mat, with other species described herein.

APPENDIX

Redescription of Marginella festiva Kiener, 1841 and designation of a neotype

Three out of five species of *Marginella* considered in this paper have been at least once referred to as *Marginella festiva* Kiener, 1841. The same name has also been used for an undescribed angolan species, and for a Brazilian species (Rios, 1970) subsequently described as *Marginella cloveri* by Rios and Matthews (1972).

In our opinion, none of these agree with the definition of the taxon by Kiener (1841). We have therefore found it useful to stabilize *M. festiva* by the designation of a neotype, as no original type material could be located.

Original reference

Marginella festiva Kiener, 1841, p. 32, Pl. 10, Figs. 4, 5. [no reference to an origin].

Shell 9 mm in length, with a rather high spire. Outer lip thickened, with faint denticulations on the inner side. Aperture narrow, parallel sided.

The body whorl carries two greenish bands with nebulous designs, and three plain pink spiral bands, all separated by narrow clear white interspace. There are conspicuous longitudinal wavy lines, fading over the pink bands, more apparent over the greenish areas and becoming intense where reaching next to the clear interspaces. The outer lip bears small pink blotches.

Possible whereabouts of type material

Much of the original material examined by Kiener is now in the Musée d'Histoire Naturelle of Geneva. Types of *M. festiva* could not be found there (Y. Finet, pers. comm.) but a specimen in the Delessert collection, catalogued under this name (no. 986.662) agrees well with the original figure and description.

Kiener (1841) states that the illustrated specimen is from the Teissier collection, which, according to Dance (1986), was later incorporated in the Delessert collection.

In the Museum National d'Histoire Naturelle of Paris, another place that holds some of Kiener's material, we found only one poorly preserved shell of this species, lacking any data of origin. Although it obviously comes from an old collection, there is no evidence that it could have been seen by Kiener.

Otherwise, we do not know of any recently collected specimen that could be referred to *M. festiva*. The species was originally described without locality data and its origin remains unknown.

Designation of the neotype (Fig. 30)

We have selected the specimen in MNHG, no. 986.662 as a neotype. Of the material known to us, it is the most likely to have been seen by Kiener.

This specimen is slightly smaller than the size given by Kiener (1841) (8.6 mm, instead of 4 lines [9 mm] in the text and 9.6 mm on the 'acutal size' drawing of pl. 10). The profile of the spire appears more bluntly rounded than on Kiener's illustration.

The chromatic pattern of our neotype agrees excellently with the original description and figure. It is not a common design in the genus, so that we consider it highly significant for the definition of the species.

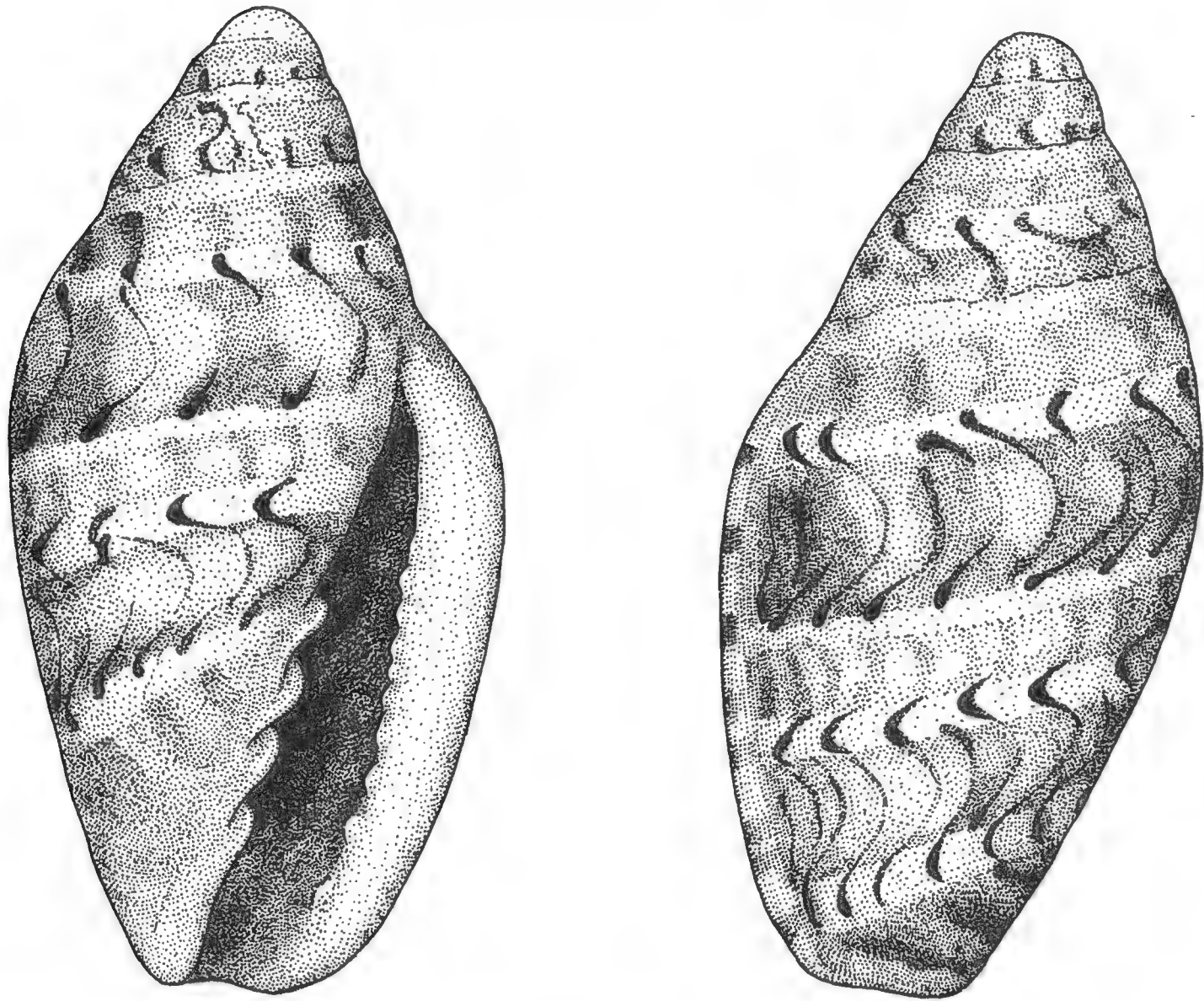


Fig. 30 a,b. *Marginella festiva* Kiener: neotype, unknown locality (MHNG 986.662). Actual size 8.6 mm.

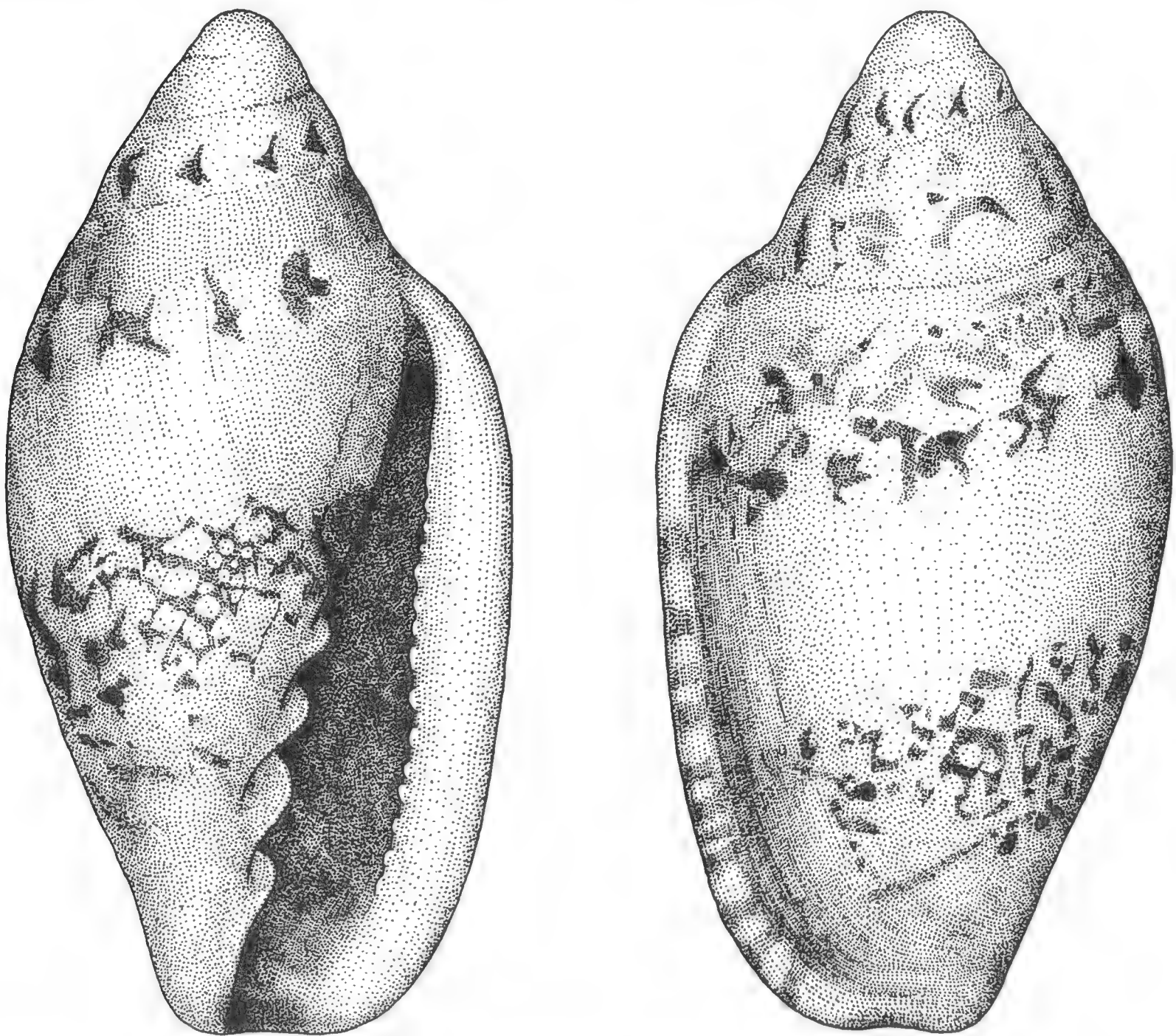


Fig. 31 a,b. *Marginella gemma* Adams: holotype, 'East Africa' (BMNH 1961135) Actual size 11.6 mm.

Remarks

We consider the following species to be related to *M. festiva*:

M. melvilli Tomlin and Shackleford (São Tomé and Príncipe islands)

M. liparozona Tomlin and Shackleford (São Tomé and Príncipe islands)

M. spinacia n. sp. (São Tomé)

M. chalmersi Tomlin and Shackleford (São Tomé)

M. gemmula Bavay in Dautzenberg, 1913 (Angola)

Marginella sp. 1 (undescribed, Angola)

Marginella sp. 2 (undescribed, Angola)

M. bavayi Dautzenberg, 1910 (Senegal)

M. cloveri Rios and Matthews, 1972 (Brazil).

The distribution of these species would suggest that the place of origin of *M. festiva* should be sought in the South Atlantic or a neighbouring area (e.g. Southern or Western Africa).

Reeve (1865) considers *Marginella gemma* Adams, 1850 as a junior synonym of *M. festiva*. We have examined the holotype of *M. gemma*, kindly communicated by Ms. K. Way (Fig. 31). We consider it as a distinct species, not closely related to the *M. festiva* group.

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THE STATUS OF *CHLAMYS VARIA* (L., 1758) AND *CHLAMYS NIVEA* (MACGILLIVRAY, 1825); AN APPRAISAL USING BIOMETRICS AND GEOGRAPHICAL DISTRIBUTION.

JANICE M. LIGHT¹

(Accepted for publication, 21st November, 1987)

Abstract: The differences in the shell characters of *Chlamys varia* (L., 1758) and *C. nivea* (Macgillivray, 1825) are investigated. Material consisting of approximately 900 specimens was measured. The specific status of *C. varia* and *C. nivea* is discussed in the light of geographical data. It is concluded that *C. nivea* is a geographical sub-species of *C. varia*.

INTRODUCTION

In June 1982 during a field trip to the Isle of Skye, Scotland, attempts to identify specimens of *Chlamys* resulted in confusion. What criteria should be used to separate *Chlamys nivea* from *C. varia*? The wider issue of the relative status of *C. nivea* and *C. varia* was raised: is the former a distinct species, or is it a sub-species, or a variety of the latter? Since rib-count and colour are used to separate these two forms, it was necessary to examine well-documented collections in order to see how these characters are geographically distributed.

Macgillivray (1825, p. 166) isolated *Chlamys nivea* from *C. varia* on the basis of the thin, diaphanous quality of the white shell and the greater number of ribs (46). He compares it to the 'thick opaque' quality of *C. varia*, the smaller number of ribs (32) and the colour as being 'various, sometimes yellowish white, yellow, brown or mottled, or variegated but never pure white.' Forbes & Hanley (1849, p. 276) elaborated on the differences, citing the narrower, more closely disposed nature of the ribs of *C. nivea*, the shape being more orbicular and the auricles being less disproportionate than those of *C. varia*. Jeffreys (1863) first recorded the incidence of colour in *C. nivea* '... snow-white, sometimes tinged with purple, or more rarely orange, yellowish, purple or brown of different shades.' He also explored the idea of habitat accounting for the shell differences; the strong few ribbed *C. varia* living on rough ground on exposed coasts, the delicate and many ribbed *C. nivea* being found in sheltered sea lochs and arms of the sea.

Jeffreys calls into question the justification of according *Chlamys nivea* specific status since its distribution was confined to 'every part of the Hebrides' and he had never seen a single specimen of *C. varia* from that district. He states 'I fear that some of my conchological friends will be terribly shocked at my innovation in uniting *Pecten niveus* and *P. varius*; but I feel constrained to take this bold step, even at the risk of not being soon forgiven. . . . The only points of difference between *P. varius* and *P. niveus* consist in the latter having a broader and flatter shell with more numerous and delicate ribs, and in the colour being white.'

Tebble (1966, pp. 59–60) leaves the question of specific status of the two forms unresolved but McMillan (1968, p. 80) lists *Chlamys varia* and *C. nivea* as separate species.

¹88 Peperharow Road, Godalming, Surrey, GU7 2PN.

METHODS

The author has examined and measured some 900 shells of *Chlamys varia* and *C. nivea*. Tables comprising the following measurements were drawn up and each specimen logged as follows: description; locality; height; length; height/length per cent; hinge length; hinge length/height per cent; rib count – right valve; rib count – left valve; umbonal angle; umbonal angle/rib count per cent; ctenolium length; width; width/height per cent.

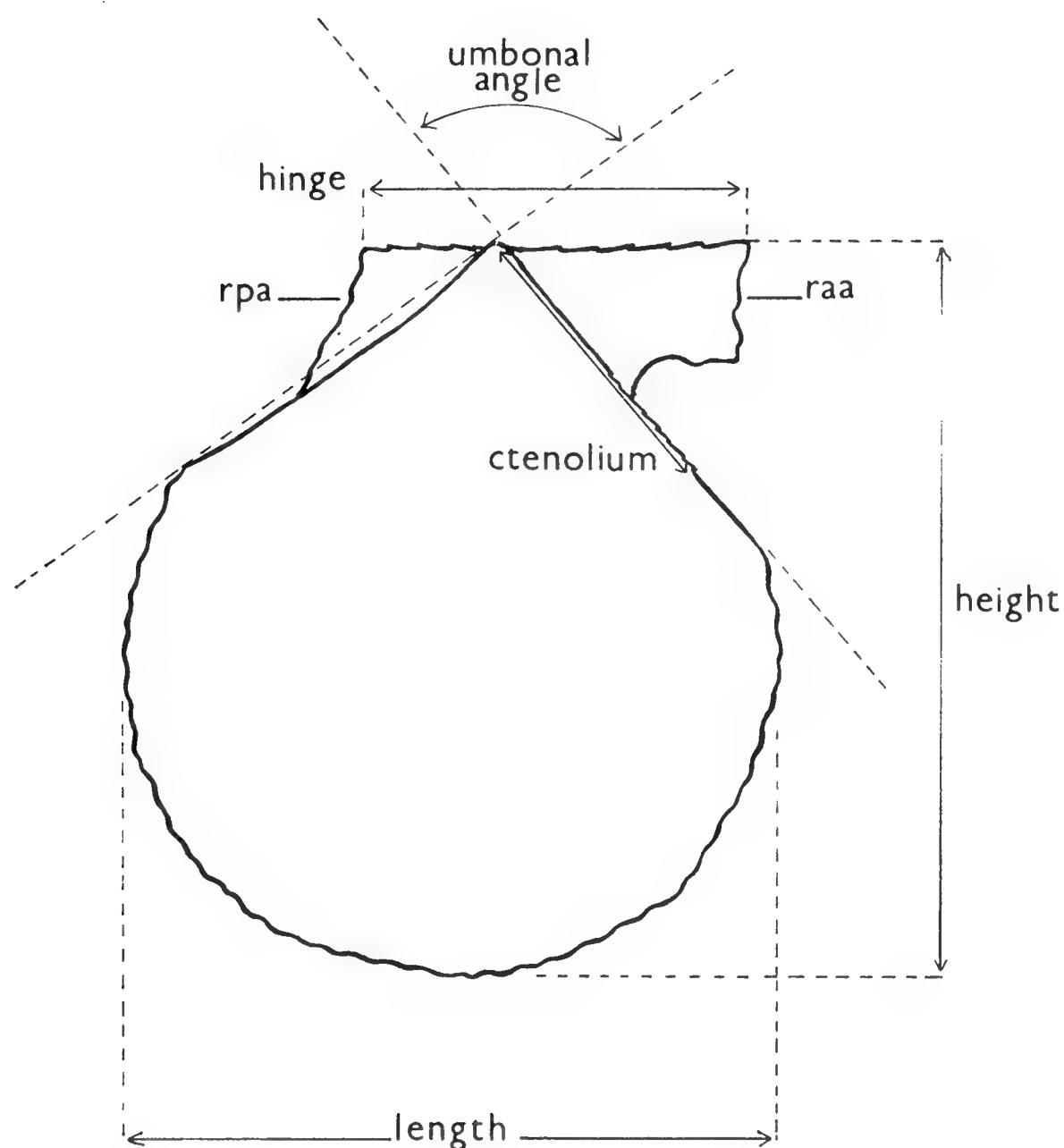


Fig. 1. Diagram of right valve of *Chlamys* to show measurements taken. rpa right posterior auricle; raa right anterior auricle.

Measurement of height, length, and hinge was made on the right valve where a complete specimen was available using calipers. To calculate height and length the hinge line of the right valve was placed parallel to one arm of the calipers in order to be consistent although this may not always have produced the widest measurement. The hinge measurement was taken from one extremity to the other and for specimens with very slight damage to the auricles, either an appropriate allowance was made where this was thought to be reliable, or in the case of excessive damage no measurement was taken. Imperfect specimens were not rejected because it was considered that the overall dimensions of the shells and the rib counts are of prime value in this study. Width was measured at the point of maximum inflation on all complete specimens except where barnacle or worm encrustation made this impossible. In addition, the ctenolium was measured from the tip of the umbone to the last tooth.

A value for umbonal angle was obtained by laying the right valve of the specimen on a card protractor made for the purpose. The right valve was used singly where possible but where complete specimens had a hinge and ligament intact and it was not deemed appropriate to separate the valves, particularly where material on loan from museums or

private collections was being used, a measurement was taken as exactly as was possible holding the specimen level and using a rule to take a line out to determine the angle.

The ribs of the right and left valve of each specimen were counted. Marginal and intercalary ribs were not included in the number logged on the tables although a notation was made where these occurred. A value for the ratio of umbonal angle to rib count was calculated using the rib count of the right valve except where the only valve available was the left.

Every specimen measured in the study was given a reference number except for batches of single valves where a single number has been allocated to the whole sample.

RESULTS

When all specimens had been measured, regional samples were made by grouping together batches from one locality, or area (e.g. Dorset coast comprising Weymouth, South Haven, Poole Harbour, Studland). Some samples, e.g. Scillies and Wells on Sea were small but were included to extend the geographical coverage. The majority of specimens measured were complete. Single valves were included where a locality or area was under-represented. One sample from the Essex beaches between Walton on the Naze and Clacton on Sea consisted of 110 unmatched valves and was considered valuable in view of the difficulty encountered in obtaining material from the east coast of Britain. Another sample from Magilligan contained 31 mixed valves including an interesting specimen with a rib count of 38.

NUMBER OF SPECIMENS

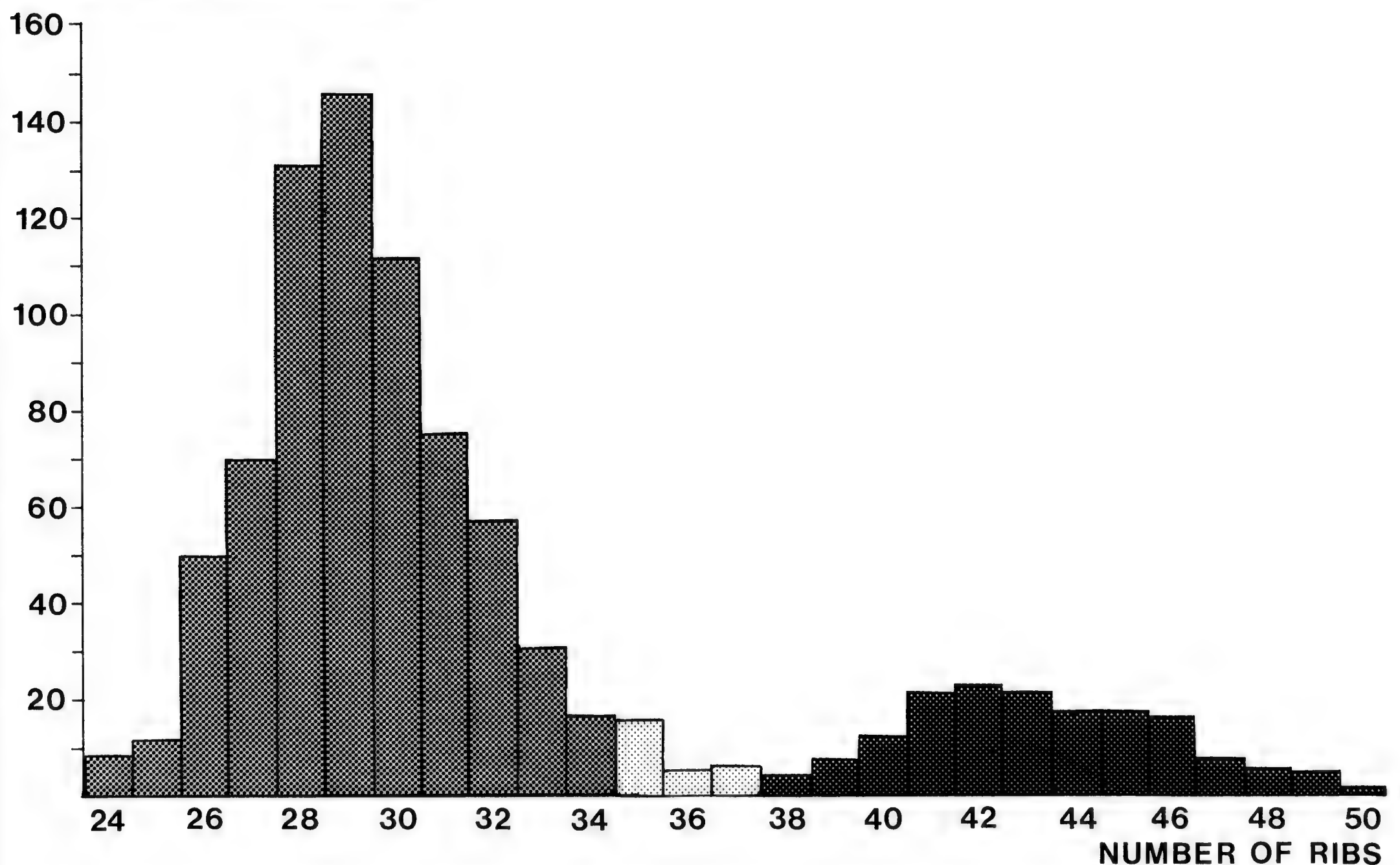


Fig. 2. Histogram to show distribution of rib count throughout the entire sample of U.K. localities (859 specimens).

TABLE 1 SUMMARY OF SHELL MEASUREMENTS

| <i>Locality</i> | <i>no. in sample</i> | <i>height/ length%</i> | <i>hinge/ height%</i> | <i>mean rib count</i> | | |
|---------------------------|--------------------------|----------------------------|---------------------------|-----------------------|------------|-----------------|
| | | | | <i>RV</i> | <i>LV</i> | <i>ua/ribs%</i> |
| <i>varia</i> | | | | | | |
| Wells on sea, Norfolk | 2 | 112.1 (1.1) | 50.4 (1.5) | 30.0 (0) | 29.5 (0.7) | 296.7 (4.7) |
| Shellness, Essex | 8 | 114.7 (7.5) | 55.0 (3.1) | 27.8 (1.0) | 28.1 (1.1) | 315.8 (28.0) |
| Sussex Coast | 9 | 117.2 (3.5) | 54.0 (4.0) | 27.3 (1.9) | 28.0 (1.9) | 309.6 (11.9) |
| Dorset Coast | 18 | 118.0 (4.7) | 55.5 (3.8) | 28.7 (1.1) | 28.3 (1.3) | 287.6 (12.3) |
| Plymouth/Dawlish, Devon | 8 | 114.8 (3.6) | 55.1 (4.2) | 28.6 (1.1) | 28.8 (1.0) | 307.5 (22.7) |
| Falmouth/Helford River | 14 | 112.2 (2.7) | 57.3 (3.8) | 29.5 (1.6) | 29.5 (1.6) | 305.9 (22.3) |
| Scilly Isles | 3 | 112.1 (2.8) | 55.0 (2.5) | 29.3 (0.6) | 29.7 (1.2) | 299.1 (22.3) |
| Channel Isles | 22 | 117.1 (3.8) | 53.8 (3.1) | 27.6 (1.3) | 27.6 (1.0) | 301.1 (17.0) |
| Bristol Channel | 23 | 112.1 (3.8) | 56.7 (3.0) | 28.8 (1.3) | 29.0 (1.3) | 310.8 (13.1) |
| Tenby, Pembs | 29 | 113.0 (3.0) | 57.8 (2.2) | 28.6 (1.8) | 28.9 (1.7) | 312.7 (23.4) |
| Milford Haven, Pembs | 25 | 111.9 (3.3) | 58.2 (3.0) | 29.5 (1.6) | 29.9 (1.7) | 304.7 (16.5) |
| West Wales | 13 | 115.6 (2.8) | 57.2 (3.1) | 28.2 (1.3) | 28.0 (1.5) | 302.8 (17.7) |
| Anglesey | 5 | 117.6 (2.5) | 55.7 (2.7) | 29.0 (1.2) | 28.2 (1.3) | 289.7 (24.3) |
| Irish Sea | 4 | 117.3 (1.1) | 55.5 (2.2) | 28.8 (1.0) | 29.0 (0.8) | 288.7 (1.4) |
| Lamlash, Arran | 14 | 114.4 (2.9) | 54.4 (3.1) | 28.8 (1.8) | 28.7 (1.3) | 303.0 (17.5) |
| Strangford Lough, N.I. | 52 | 112.3 (3.8) | 58.1 (2.6) | 30.8 (2.2) | 31.3 (2.2) | 289.8 (19.2) |
| Lough Swilly, N. Ireland | 47 | 112.0 (3.5) | 60.4 (3.7) | 30.3 (1.6) | 30.3 (1.7) | 296.7 (19.8) |
| Ballyvaghan, W. Ireland | 10 | 110.9 (3.8) | 60.5 (2.1) | 29.1 (0.7) | 29.3 (1.1) | 315.5 (8.7) |
| Dingle, S. Ireland | 19 | 105.0 (3.0) | 62.6 (3.1) | 30.2 (1.8) | 30.3 (1.6) | 318.4 (17.1) |
| Kenmare River, S.I. | 17 | 115.3 (3.7) | 57.3 (4.4) | 31.5 (2.2) | 31.4 (2.2) | 274.8 (17.3) |
| Bantry Bay, S.I. | 18 | 109.0 (3.0) | 60.2 (3.5) | 31.1 (1.7) | 31.2 (1.8) | 300.9 (20.6) |
| Firth of Clyde, Argyll | 5 | 113.0 (4.5) | 55.7 (5.0) | 29.6 (1.7) | 29.6 (1.5) | 301.8 (19.4) |
| West Scottish coast | 13 | 110.9 (3.5) | 56.5 (4.3) | 30.4 (2.0) | 30.5 (1.6) | 301.0 (22.7) |
| Loch Roag, Lewis | 25 | 111.0 (3.5) | 59.4 (3.9) | 32.8 (1.8) | 32.9 (1.6) | 281.5 (15.7) |
| Orkney | 44 | 110.8 (3.5) | 60.0 (3.7) | 29.7 (1.3) | 29.8 (1.4) | 308.5 (14.5) |
| East Scottish coast | 7 | 113.5 (3.3) | 57.1 (2.9) | 29.0 (1.8) | 29.0 (2.8) | 302.1 (16.4) |
| European localities | 33 | 113.2 (4.6) | 54.1 (3.2) | 29.3 (1.6) | 29.7 (1.6) | 298.4 (18.9) |
| Bergen, Norway (sample 1) | 30 | 108.0 (3.1) | 61.6 (3.5) | 29.7 (1.8) | 29.4 (2.0) | 320.1 (19.1) |
| Bergen, Norway (sample 2) | 24 | 107.7 (2.9) | 61.0 (3.9) | 29.0 (1.8) | 29.0 (1.7) | 329.7 (21.8) |
| <i>'intermediate'</i> | | | | | | |
| Scottish localities | 8 | 109.6 (3.2) | 55.2 (3.3) | 35.5 (1.1) | 36.0 (1.2) | 260.1 (11.5) |
| <i>nivea</i> | | | | | | |
| Oban | 56 | 109.1 (3.0) | 49.3 (2.9) | 43.0 (3.1) | 42.8 (2.8) | 228.6 (16.6) |
| Isle of Skye | 51 | 109.5 (3.3) | 51.6 (3.3) | 43.2 (2.7) | 43.3 (2.9) | 223.3 (14.7) |
| Other West Scottish locs. | 36 | 110.6 (3.59) | 52.5 (3.0) | 43.2 (2.5) | 43.1 (2.9) | 218.6 (12.0) |

Notes:

Figures in parentheses are standard deviations based on $\delta n-1$.

ua, umbonal angle; RV, right valve; LV, left valve.

Where 'intermediates' occur in other than Scottish populations, these have been included with the appropriate 'varia' sample.

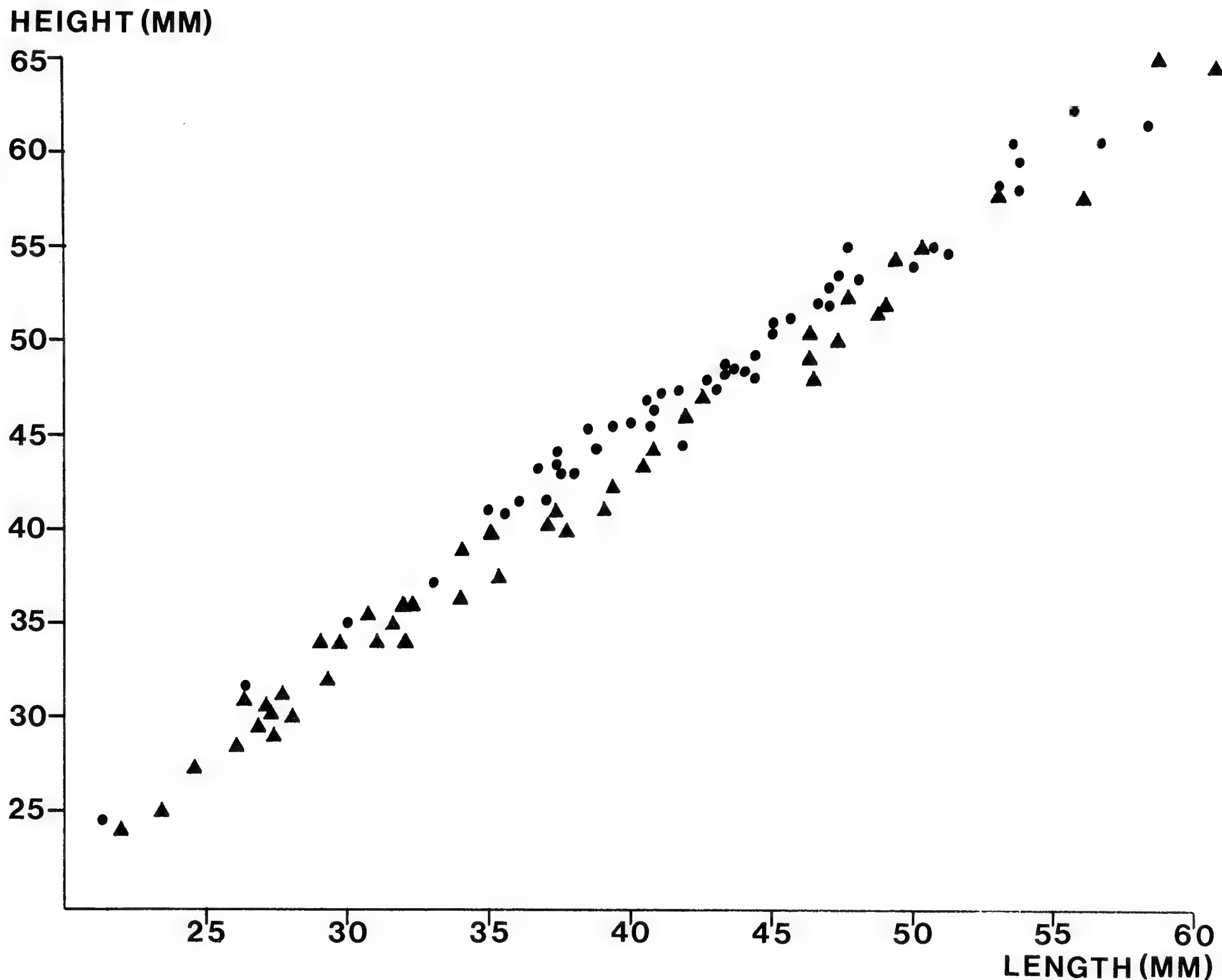


Fig. 3. Scatter-diagram to show height/length ratio between a selected sample each of *Chlamys varia* (closed circles) and *C. nivea* (triangles).

Fig. 2 shows the bimodal distribution of rib count with modes for the form *varia* (29 ribs) and for *nivea* (41/42 ribs). A lower peak for *nivea* is the result of a sample totalling about one-fifth the size of that obtained for *varia*.

Table 1 lists the mean values of measurement ratios recorded, grouped by locality or area. Data for width of specimens is not included since a mean value of approximately 37% was obtained throughout. No significance was found in the ctenolium measurements. The sample of specimens from mixed European localities (excluding Norway) and the two Norwegian samples are included as comparative data.

In order to obtain direct comparisons between *Chlamys varia* and *C. nivea*, two samples of approximately 50 specimens each were selected. The sample for *varia* consists of specimens from Milford Haven and Tenby, a typical example of which is illustrated in Pl. 4. The *nivea* sample comprises specimens collected from a length of coast on Skye between Broadford Bay and Loch Ainort. Fig. 3 shows a direct comparison between the height/length ratio of both samples. Fig. 4 illustrates the relationship between the hinge length and height of both forms and Fig. 5 shows the ratio of number of ribs plotted against the value for umbonal angle. The values for a sample of eight 'intermediate' specimens were included on Fig. 5.

Fig. 6 shows a map on which most of the material measured for this study has been plotted by locality. Records from literature have not been included.

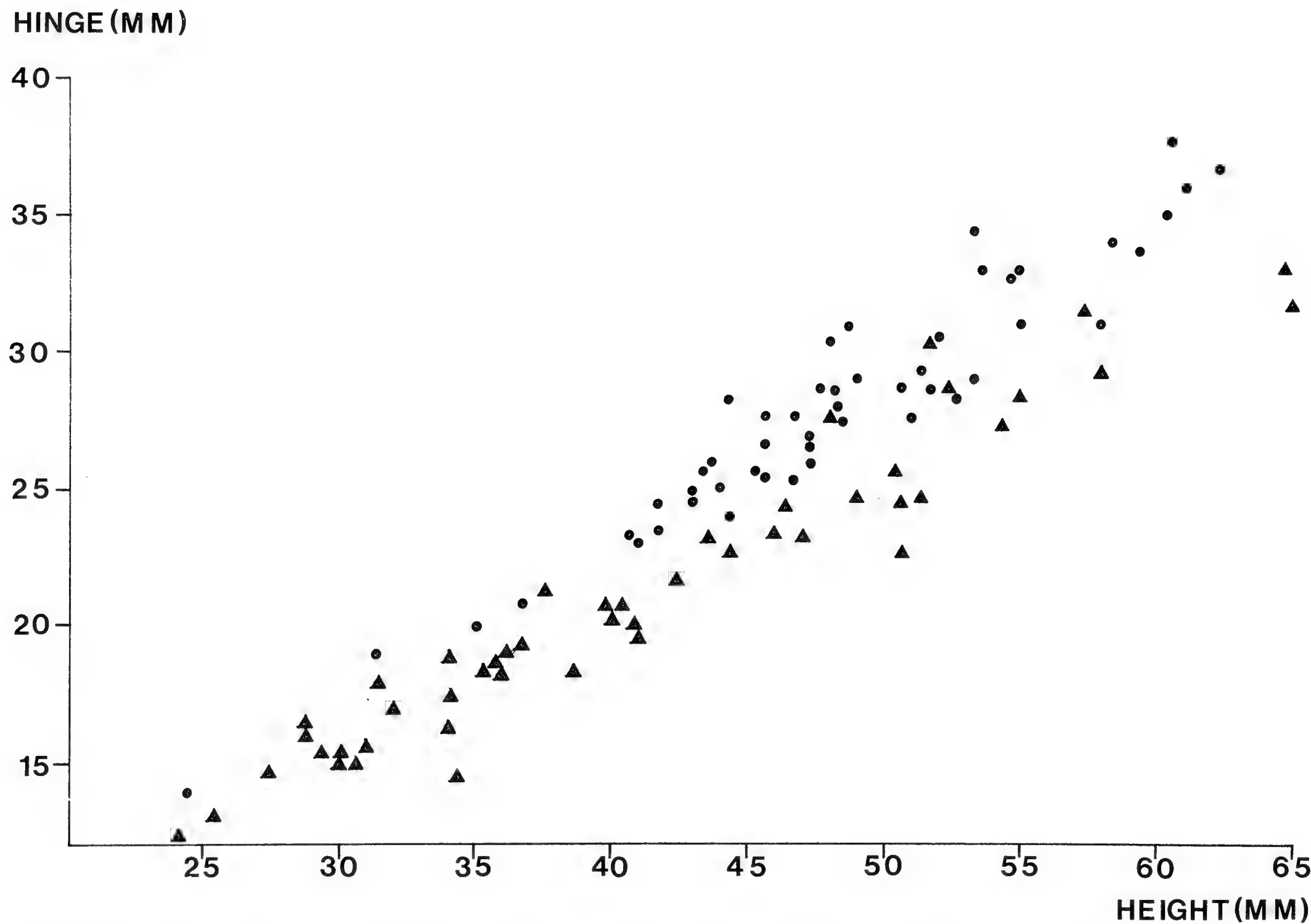


Fig. 4. Scatter-diagram to show the relationship between hinge length and height of both samples. Closed circles denote *C. varia* and triangles denote *C. nivea*.

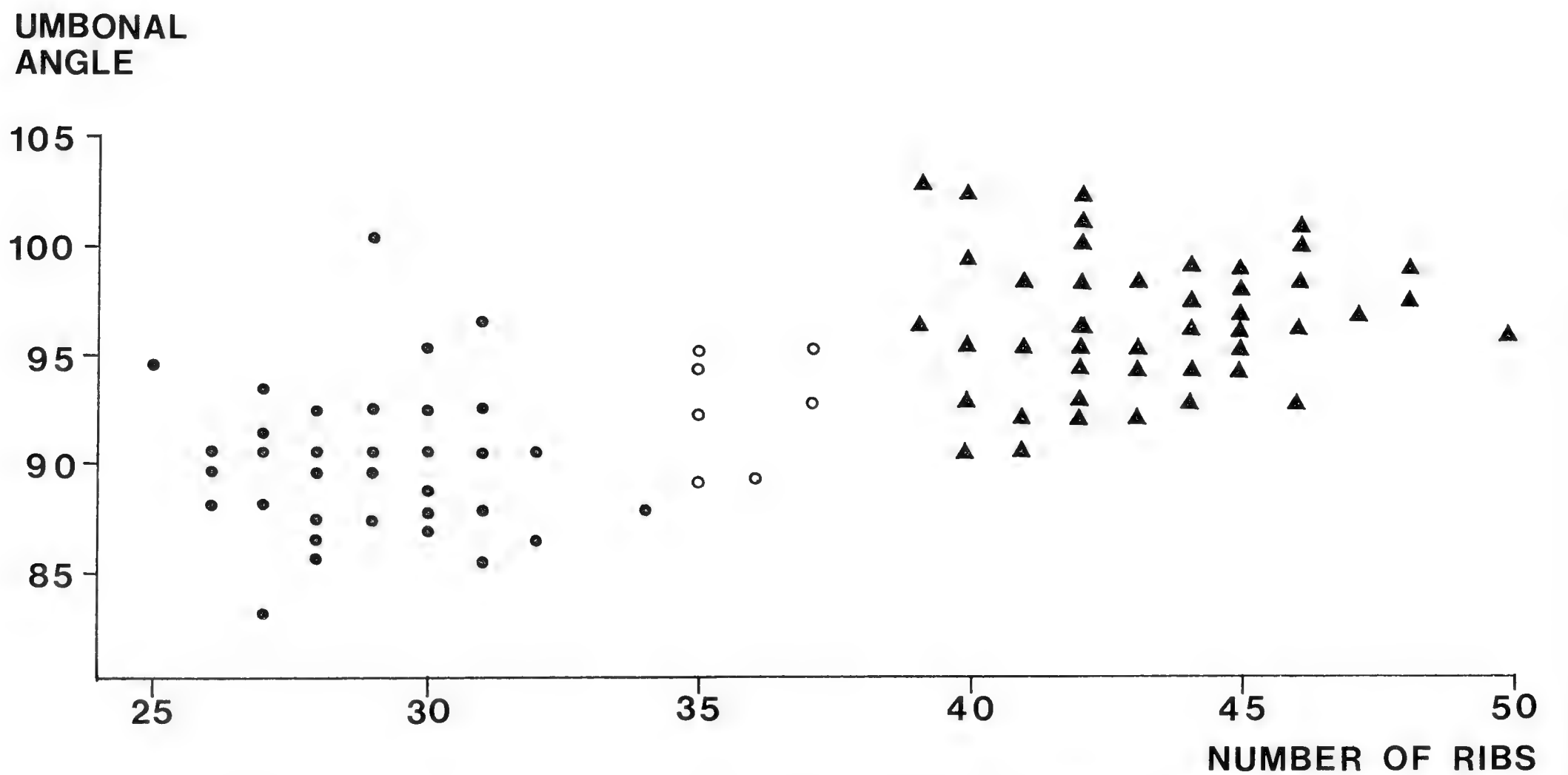


Fig. 5. Scatter-diagram to show the relationship between umbonal angle and number of ribs. Closed circles denote *C. varia*, triangles denote *C. nivea* and open circles denote 'intermediates'.

LIGHT: *CHLAMYS VARIA*

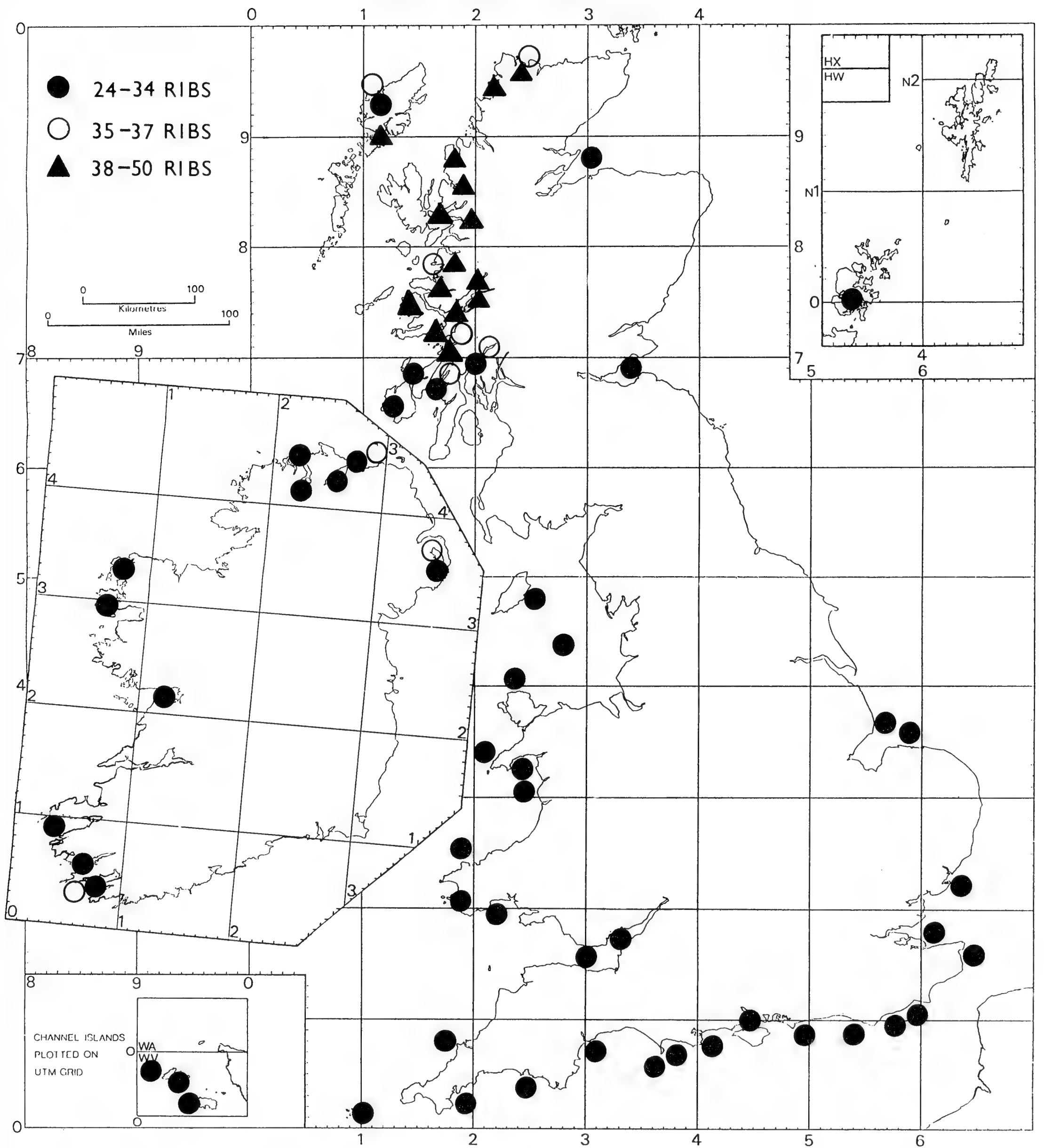


Fig. 6. Map to show collection locality of material measured. Records from literature are not included.

DISCUSSION

The information presented in Fig. 2 shows that, of the criteria used for separating *Chlamys varia* from *C. nivea*, the rib-count factor is still a valid one. However, a small number of specimens have an intermediate rib-count of between 33 and 40. Of these, specimens with a rib-count of between 35 and 37 inclusive have been termed 'intermediates' for the purposes of this study. These parameters were selected because no *Chlamys* from the east and south

coast, nor from the west coast as far north as Cumbria had a rib-count in excess of 34 ribs. This value was therefore set as an upper limit for *varia*. A lower limit of 38 ribs for *nivea* was chosen since some adult and juvenile *Chlamys* from a *nivea* population would have as few as 38 ribs whilst resembling typical specimens of the population in all other respects. The only specimen to be excluded from this categorisation is a single adult valve from Magilligan, Northern Ireland with a rib count of 38 which the author regards as an aberrant *varia* or possibly an intermediate.

It can be seen from the information presented in Table 1 that, in addition to rib-count, other characters cited by previous authors regarding the differences in *Chlamys varia* and *C. nivea* are still applicable. There is an average reduction of 3.4% in the height/length ratio of *nivea* compared to *varia*. The reduction in value of the former is, however, matched by some *varia* samples, notably Bantry Bay and Orkney. This latter sample merits further study since all individuals within this population are white and may represent a 'giant' race; the specimens measured by the author having a mean height of 60.6 mm with a maximum height of 91.4 mm. [Heights in the region of 100 mm have been recorded (Ian Smith pers. comm.)]. A similar tendency to an overall increase in size and virtual restriction to white colouring (with the exception of three coloured specimens out of a total of 107 including single valves) occurs in another relatively isolated population in Loch Roag on the north east coast of Lewis (Pl. 4, fig. 2).

The difference between the hinge/height ratio of *nivea* and *varia* samples (approximately 5%) reflects the smaller anterior auricle of the former, and is shown in Fig. 4. The greater number of ribs in *nivea* does partially account for a larger umbonal angle in some specimens but the increase is not a proportionate one. The mean rib count for *nivea* within the sample is 43.3 with a mean umbonal angle of 96.2. This compares with 29 ribs for a mean angle of 89.5 in the *varia* sample. The ribs are more closely distributed across the shell of *C. nivea*.

An examination of intercostal sculpture and the scales on the ribs in examples of each form reveals no appreciable differences.

The existence of intermediates within the whole sample indicates that the two forms are not disjunct and that there is a continuous rib-count from 25 to 50 showing them to be genetically very close but separable on shell characters. A convincing reason for the separation of *Chlamys varia* and *C. nivea* is shown in Fig. 6. The confinement of *nivea* to West Scotland is strong evidence for regarding it as a geographical sub-species. Discounting intermediates, true *varia* and *nivea* appear, from material available, to have a disjunct distribution along latitude 56° 15' N. The occurrence of intermediates across this boundary is significant. Since the mode of reproduction involves the shedding of gametes into the open sea, gametes from populations of *C. varia* may well be carried by sea currents north to unite with those of *C. nivea* populations thus producing hybrids. Another factor to be considered is the possibility that intermediate forms may result from a habitat where intermediate environmental conditions are present. Development of this hypothesis would involve the collection and measurement of material from specially selected sites which represent an intermediate type of habitat.

Chlamys with rib-counts of 35 to 37 also occur where the population of *C. varia* sampled has an higher than average rib count, e.g. South West Ireland and Strangford Lough where geographical features produce a degree of shelter resembling the coast of West Scotland. These intermediates are not likely to be hybrids since there are no populations of *C. nivea* living nearby and thus are more likely to be aberrant specimens of a population whose mean rib-count is higher than that recorded for *C. varia*.

Another area where similarity of geographical features occurs is the fjordic system along the coast of Norway where sheltered bays and rocky sea arms comparable with the habitat of *Chlamys nivea* occur. Norman (1879, p. 35) recorded the Mollusca of the Bergen Fjords and lists *C. varia* noting that it is absent from the 'Scotch coast' although the form *nivea* is

present. The typical Norwegian *varia* is likened to the form from Southern Britain. Lucas (1979) postulates that *C. nivea* does live along the Norwegian coast but is confused with *C. varia*.

There are references in literature to records of *Chlamys nivea* and *C. varia* from localities not recorded in Table 6 (Knight 1903, pp. 211, 214, 1906a, p. 146, b, pp. 214–215, Swanton 1912, p. 67–68). Without knowledge of the criteria used for separating the two forms the author feels that some of these records may be misidentifications or refer to *Chlamys* that would fall into the intermediate category as described in this paper. It is worth noting that despite some of these early records for *C. nivea* from varied Scottish localities, 85% of the specimens of *C. nivea* from old collections examined for this study are localised to Oban. A typical example of *C. nivea* from an early collection is figured in Pl. 3.

Another interesting feature of these 'older' specimens is that of 55 individuals measured, only 14.5% show some colour, whereas of 48 randomly collected specimens of *Chlamys nivea* taken within the past five years, 42% are coloured; some specimens having the typical variegated and mottled patterns and colouration of *Chlamys varia*. The most recently collected example is figured on Pl. 3 and was taken by a diver off Skye. The pattern and colour resemble a typical *C. varia* but the very thin shell, rib-count (47) and locality link the specimen more closely to the *nivea* identity.

An additional 41 specimens of *Chlamys nivea* have been contributed by modern workers, notably Dr. S. M. Smith and 51% of these are coloured specimens. Smith notes (pers. comm.) that coloured *nivea* are frequently associated with a habitat involving the undersides of boulders in rapids and waterfall systems and in gathering her material she made no deliberate attempt to collect coloured specimens to the exclusion of white ones. The incidence of colour in *C. nivea*, therefore, appears to be more frequent than recorded by early workers. If this does not represent selective collection, it may well signify a quantitative increase. Possibly some modification of the original habitat by pollutant or other factors, or change in food type or supply has brought about a dilution of the original *C. nivea* as described by Macgillivray.

White specimens of *Chlamys varia* occur in samples from localities around the Irish coast, along the west coast of Britain and along the south coast as far east as Plymouth.

Pl. 3 shows a *Chlamys nivea* collected from Loch Eriboll. Although *C. varia* was also recorded from Loch Eriboll on the same occasion, no voucher material was available for measurement. This is the only locality on the north coast of Scotland from where material has been available and precise information is needed as to where *C. varia* recurs along this coast.

Brown (1878, p. 5) and Allen (1962, p. 54) list *Chlamys varia* as living in the Clyde and question the occurrence of *C. nivea* from the same district. Two *Chlamys* specimens collected off Great Cumbrae in the Clyde were received from the University Marine Biological Station at Millport. Both specimens are white and have rib counts of 32 and 37. The latter specimen (Pl. 2, figs. 3A,B) is a typical example of the intermediate form.

Somerville (1860, p. 7056) records the incidence of *Chlamys nivea* on the shores of Mull. Its range is cited as not extending further south than Oban; it has never been observed in the Firth of Clyde although the coasts have been frequently searched and the dredge has been used in deep water. In a list of marine molluscs from Oban, Chaster and Heathcote (1894, p. 305) record *Chlamys varia nivea* and cite the 'type' as 'conspicuously absent'. They state 'With regard to the *niveus* form the writers are at variance, one considering that it is fully entitled to specific rank, whilst in the opinion of the other the arguments adduced by Jeffreys are too weighty to be lightly discarded. It seems that it ought to be possible to finally settle the question by tracing the species from Oban to Loch Fyne where, as in the whole Clyde district, the type only occurs, and by noting the presence or absence of intermediate forms.'

SUMMARY

As a first step towards elucidating the specific status of *Chlamys nivea* in relation to *C. varia*, shell characters have been compared and distribution has been investigated. In gathering information from the material available, evidence of co-occurrence of *Chlamys varia* and *C. nivea* on the same stretch of coast or within the same relatively confined sea area (not to be confused with the Conchological Society's Marine Census Areas) was sought. The two forms appear to be mutually exclusive. The map in Fig. 6, however, is regarded as a provisional one and in publishing it at this point, it is hoped that more material may be forthcoming in order to take this research a stage further.

CONCLUSION

The evidence adduced during the course of this study strongly supports the hypothesis that, at the present level of knowledge, *Chlamys nivea* is a geographical sub-species of *C. varia* confined to the west coast of the Scottish mainland.

MATERIAL AND ACKNOWLEDGEMENTS

The data presented in this paper are taken from specimens loaned by the Institutions and individuals listed below. Owing to the restrictions imposed by the arbitrary range of localities from which material has been collected and consequently available to the author, statements and conclusions presented in this paper about the biometrics and distribution of *Chlamys varia* and *C. nivea* are based on the information that was available, and in the absence of conflicting contemporary evidence.

Source

British Museum (Natural History),
London

National Museum of Wales, Cardiff

Royal Scottish Museum, Edinburgh

Glasgow Museum.

University Marine Biological Stn.,
Millport
Liverpool Museum.

Trondheim Museum, Norway

Blomsterdalen Marine Inst. Bergen,
Norway.

Origins of material

Collections of Fowler, Rowe-Weiner, Norman, E. A. Smith, McAndrew and several others.

Collections of Marshall, Chaster, Bartlett Span and Dr Y. H. Mills

Selected material including S. M. Smith specimens.

Collections of Robertson, Somerville, and Knight.

David Robertson material.

Specimens collected by M. Long, N. F. McMillan and I. Smith.

Selected specimens including Soot-Ryen Collection.

Two samples collected for comparative study.

Certain specimens seen by the author have been excluded from this study owing to inadequate data or doubts about the authenticity of the locality. These include batches of *Chlamys varia* from the Fowler Collection, some David Robertson specimens and a solitary

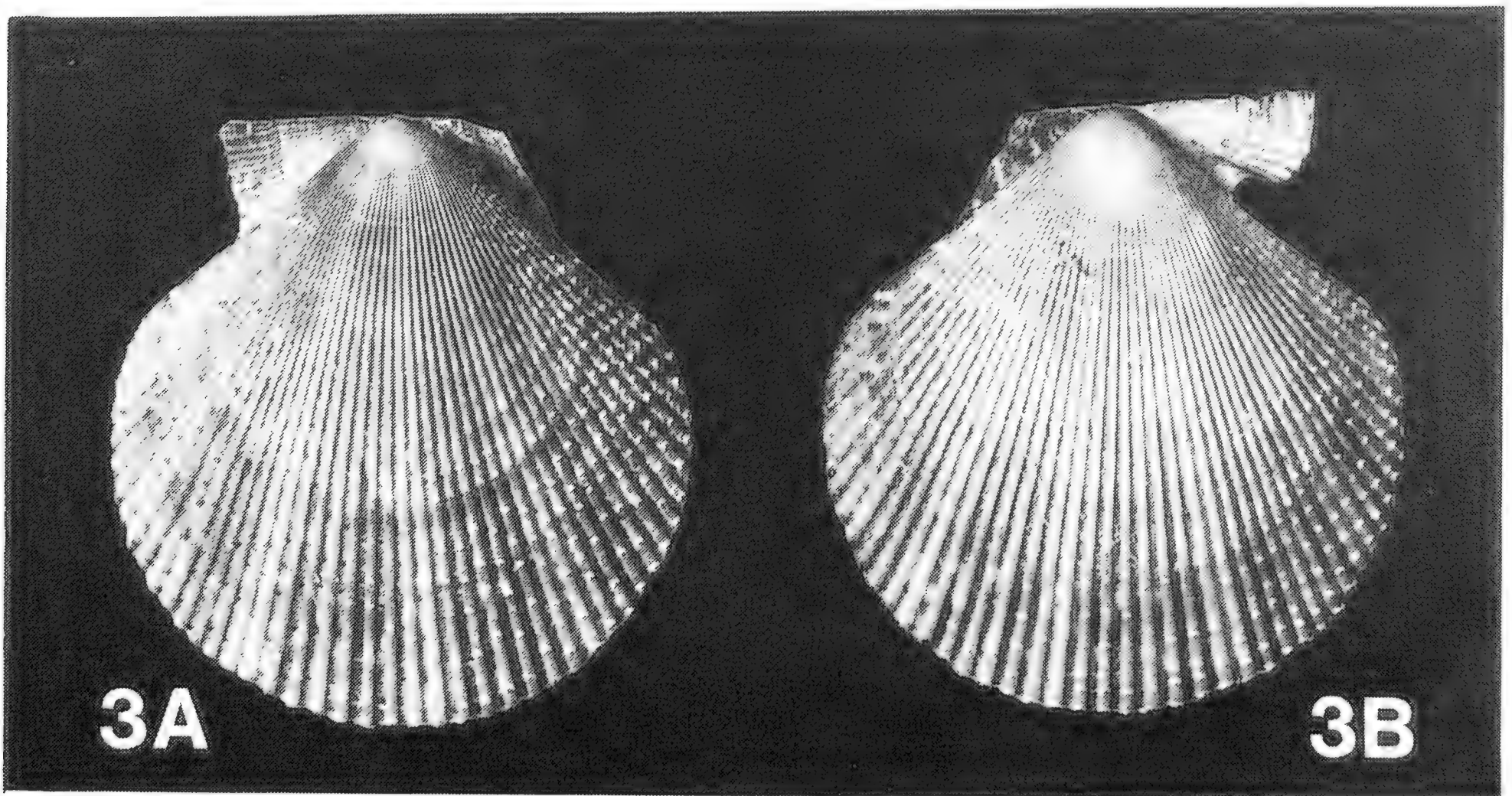
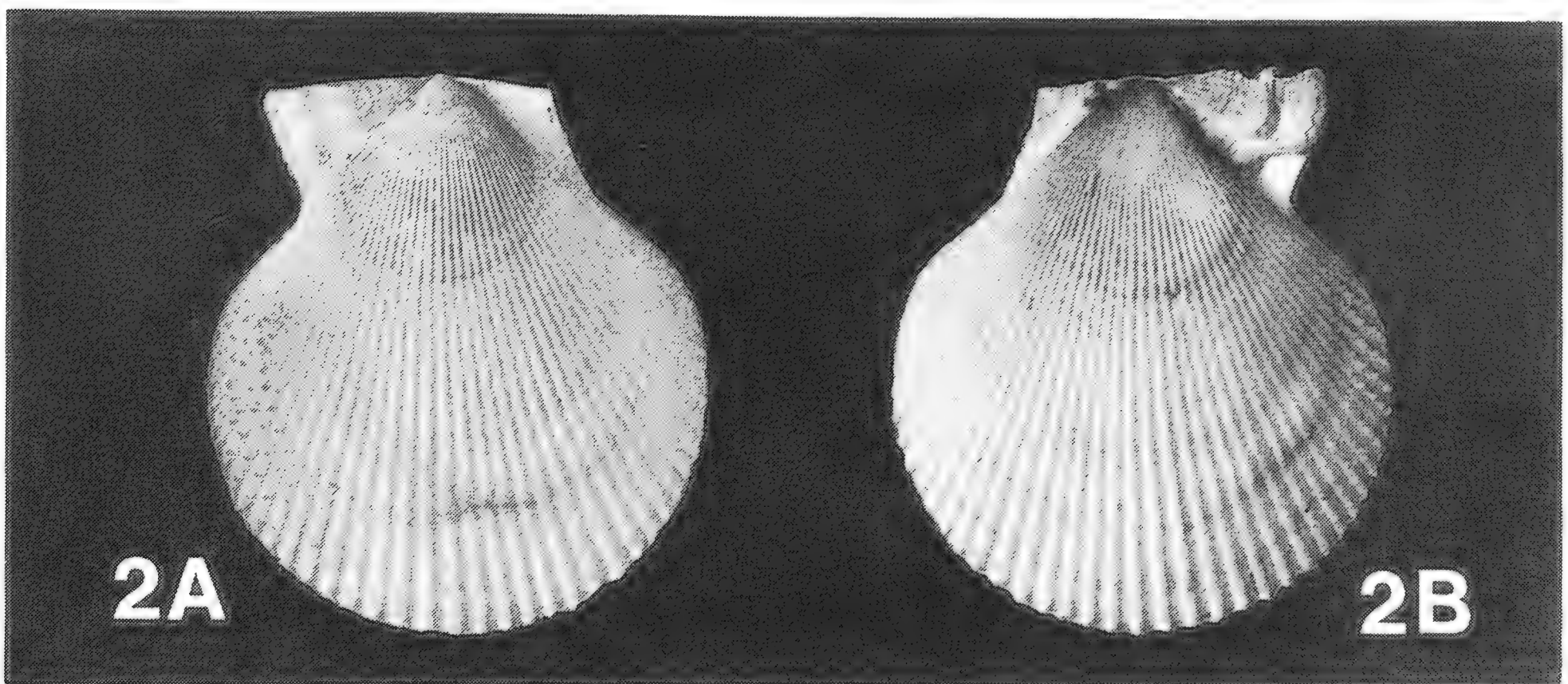
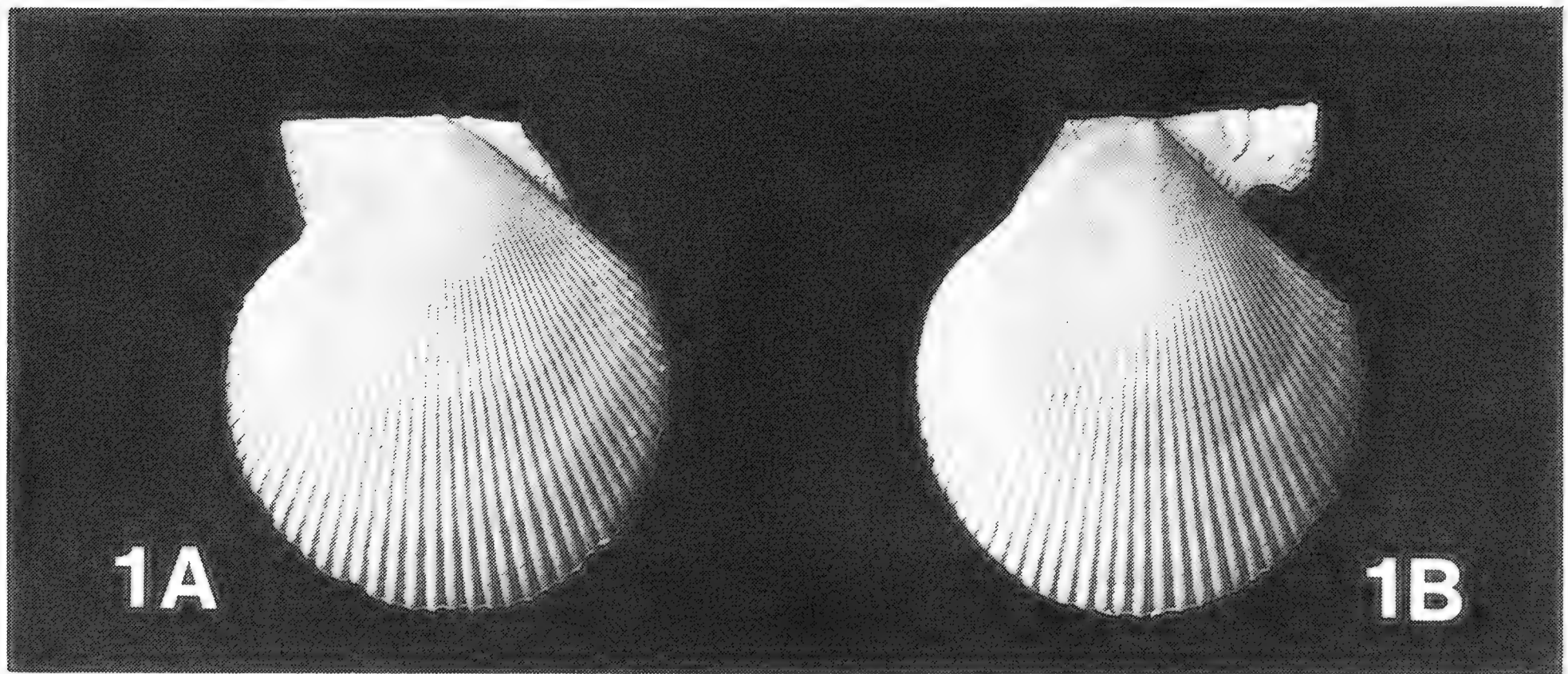


PLATE 3

1A, 1B *Chlamys nivea* from Oban ref. no. N12. Actual height 41.5 mm. 2A, 2B *C. nivea* from Loch Eriboll ref. no. RGM55. Actual height 54 mm. 3A, 3B *C. nivea* from Broadford Bay, Skye ref. no. JLN1. Actual height 51.3 mm. J. Light reference numbers have been lodged with specimens.

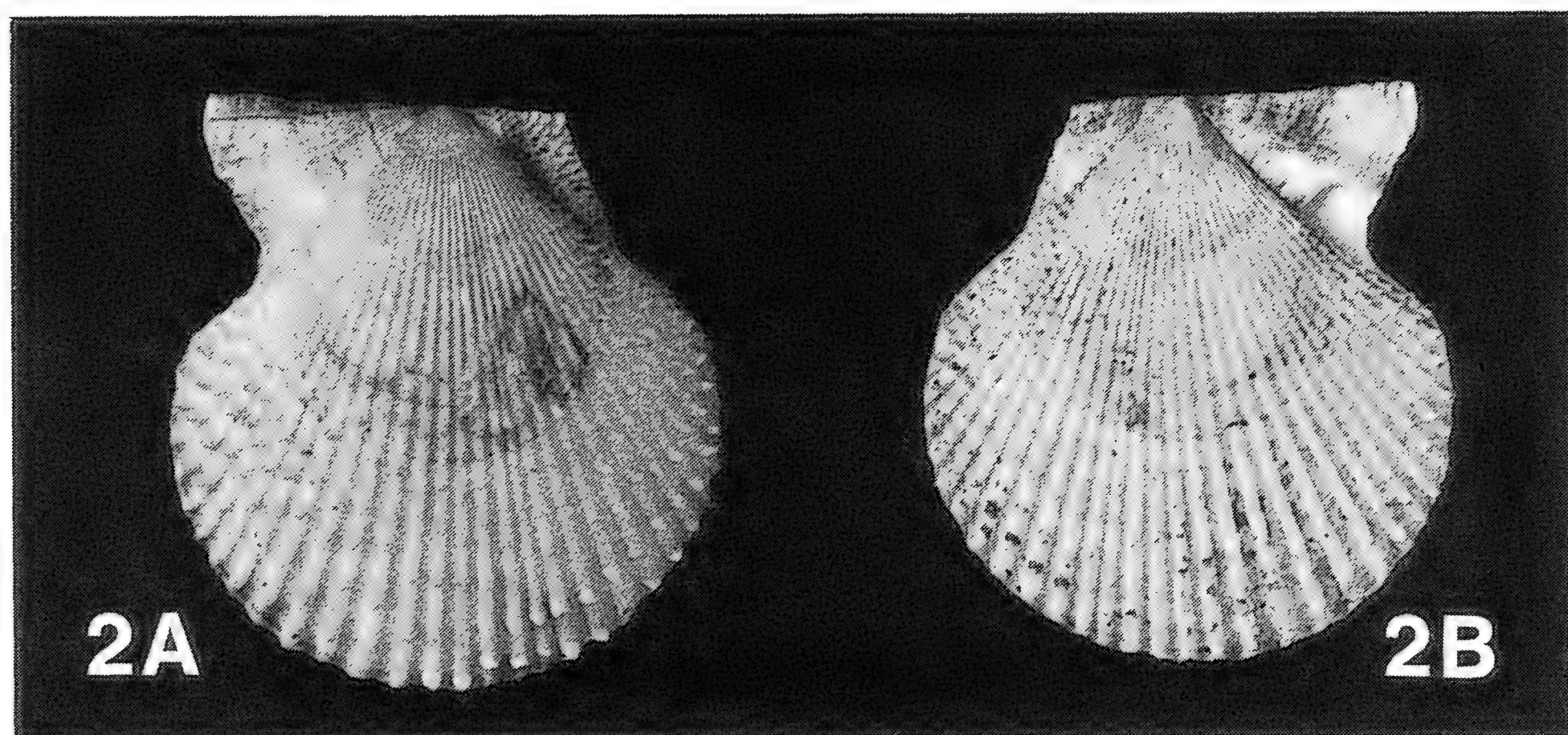
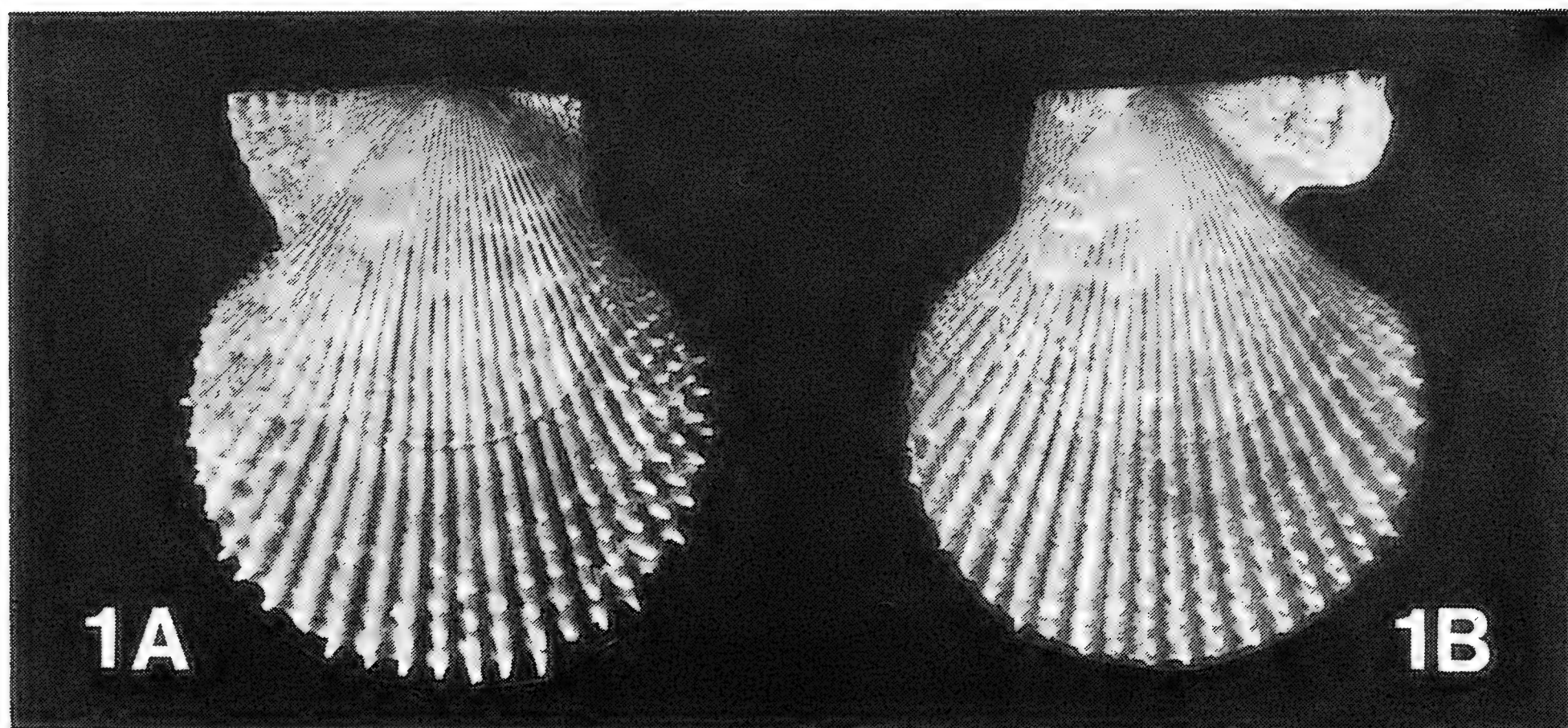


PLATE 4

1A, 1B *Chlamys varia* from Milford Haven ref. no. BM110. Actual height 47·8 mm. 2A, 2B *C. varia* from Loch Roag ref. no. RGM138. Actual height 55·5 mm. 3A, 3B 'intermediate' form from Firth of Clyde ref. no. UMBS2. Actual height 49·7 mm. J. Light reference numbers have been lodged with specimens.

LIGHT: *CHLAMYS VARIA*

Chlamys nivea recorded from St. Mawes, Cornwall emanating from the Salisbury Collection. Information relating to *Chlamys* specimens collected by Barlee from Glengarriff Bay which are in the Jeffreys Collection in the Smithsonian Institute, Washington is contained in a letter from Dr. T. Waller to Mrs. McMillan (1970). One specimen has a rib count well in excess of 40 but radials introduced by bifurcation or intercalation were included and have been omitted from the data used in the calculations for the present study. There is also Barlee material in the Zoological Museum of Oxford University but these specimens lack data. Further Barlee specimens are held by the Hancock Museum, Newcastle but *C. varia* and *C. nivea* are not included. It seems that the occurrence of *C. nivea* from south west Ireland is based on the Barlee record.

ACKNOWLEDGEMENTS

During the course of this study I have received help and encouragement from a large number of people. I would like to thank Mr. David Heppell, Mrs. Solene Morris, Dr. Graham Oliver, Dr. T. Stromgren, Dr. I. Wallace and Mr. Fred Woodward for making material and literature from museum collections available to me; also for helpful discussions. I am greatly indebted to Mrs. Nora McMillan who passed notes and data to me which she and Mr. David Harfield assembled some fifteen years previously in order to carry out a similar study. I would like to thank the following people for the loan or supply of specimens: J. A. Allen, R. N. Bamber, J. B. Brockbank, S. Francis, S. Freemantle, D. T. Holyoak, J. L. Jones, N. F. McMillan, R. J. Meiklejohn, C. J. Pain, C. P. Palmer, R. Parry, T. H. Watson, T. Worsfold and particularly J. D. Nunn, B. E. Picton, S. M. Smith and T. Solhoy who provided specially collected samples. I am grateful to Dr. D. T. Holyoak for his advice and criticism of the draft typescript and special thanks must go to my husband, Nick, for his constant encouragement and to Mr. Phil Palmer for suggesting the project, producing the plates, and invaluable advice and guidance in the preparation of this paper.

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REVIEW

Plant molluscicides, edited by K. E. Mott, September 1987, J. Wiley, Chichester, New York etc., 326 pp, 23·9 × 15·8 cm.

Almost 40 years ago when, because my hobby was the study of non-marine molluscs, I was asked to try to name *Bulinus* and *Biomphalaria* bilharzia carriers for the Department of Insect-Borne Diseases in Nairobi, much use was made of such substances as copper sulphate and various pentachlorophenates for snail control. The disastrous ecological effects resulting from this can be imagined. I was therefore very interested when Dr Teesdale in 1950 asked me to investigate the use of a plant as a potential snail-killer. My chemist friend Dr P. R. Hesse carried out an analysis and discovered saponins and rotenones. It was hoped that use of plants growing on the spot would prove a cheaper means of control and involve far less deleterious ecological consequences. Such attempts had been made with several plants eg *Balanites* since the mid-1930s. Snail control proved less successful than anticipated and bilharzia workers turned to curing patients combined with teaching them hygiene. Despite ever increasing activity by numerous bodies worldwide since schistosomiasis (bilharziasis) was discovered by Theodor Bilharz in 1851, enormous numbers of people are infected – estimated at present as between 200 and 300 million. Vast new irrigation schemes have of course greatly aggravated the problem.

The present work brings together papers presented at a meeting in Geneva of the Scientific Working Group on plant molluscides under the auspices of an UNDP/World Bank/WHO special programme. The first paper deals generally with the uses of molluscicides in control of the disease putting the history of those derived from plants in perspective with other control methods. Their mode of action is dealt with in the second paper. Much of the book is naturally taken up with detailed lists of plants with recognized or potential activity and their biochemistry and untapped sources of further information. The possibility of cultivating suitable plants is also discussed. Papers on toxicological screening, laboratory and field evaluation and work in China complete the book.

This is a series of exhaustive extremely well documented papers underlining the immense amount of work which has been accomplished mostly in the past quarter of a century. As an example of bringing together information from innumerable widely dispersed sources it is really quite masterly. The long lists of botanical names have certainly been scrutinised by someone knowledgeable and are not blighted by numerous spelling mistakes so frequent in other publications of a similar nature.

B. VERDCOURT

THE GENUS *VITREA* IN IBIZA

A. NORRIS¹, C. R. C. PAUL², AND A. RIEDEL³

(Accepted for publication, 21st November, 1987)

Abstract: The shells, anatomy and distribution of two species of *Vitrea*, one new and both endemic to Ibiza, are described. *V. striata* nov. is characterized by a strongly striate, perforate shell with shouldered whorls and a step-like spire. The vagina is surrounded by a gland in the middle third and the spermatheca is long and cylindrical. It is only known from Cala Sant Vicens. *V. gasulli* Riedel & Paul has a smooth perforate shell with more evenly rounded but also somewhat shouldered whorls, a vagina surrounded by a gland near its apex and an elongate pyriform spermatheca. *V. gasulli* is common and widespread in Ibiza.

INTRODUCTION

In 1984 and 1985 two of the authors visited the Spanish Mediterranean island of Ibiza and collected non-marine molluscs, AN in November, 1984 and CRCP in August, 1985. In the wetter conditions of late autumn AN was able to collect many live molluscs, including several samples of *Vitrea*. In the hot summer CRCP could not find any live *Vitrea*, but did collect some shells of a new species by sieving moss and leaf litter under bushes at the foot of the cliffs just inland on the south side of Cala Sant Vicens (Cala San Vicente, Fig. 1). AR confirmed that the shells represented a very distinctive new species. By good fortune AN had also located the new species alive at about the same spot and had preserved some examples in alcohol. He also collected and preserved live specimens of the other endemic

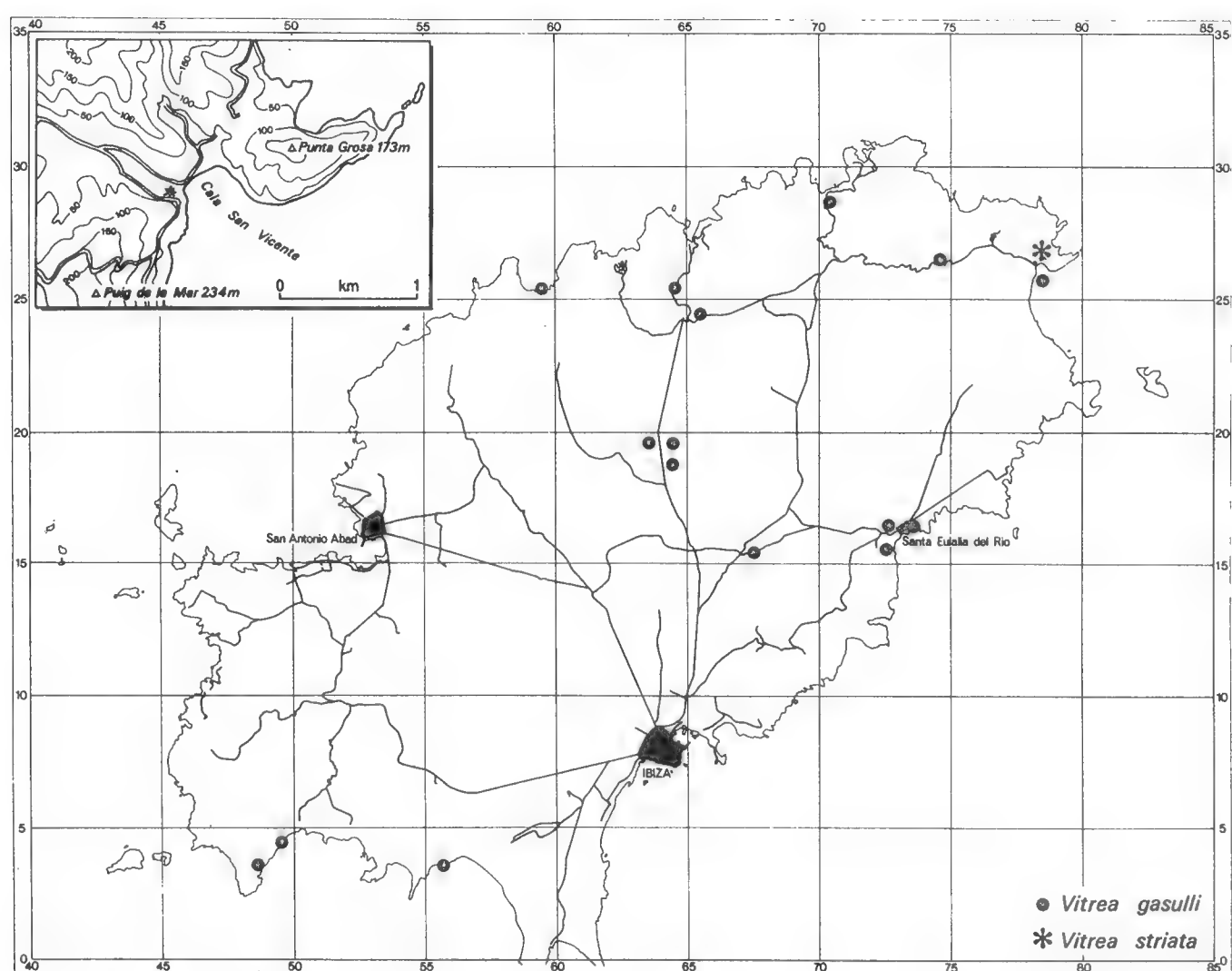
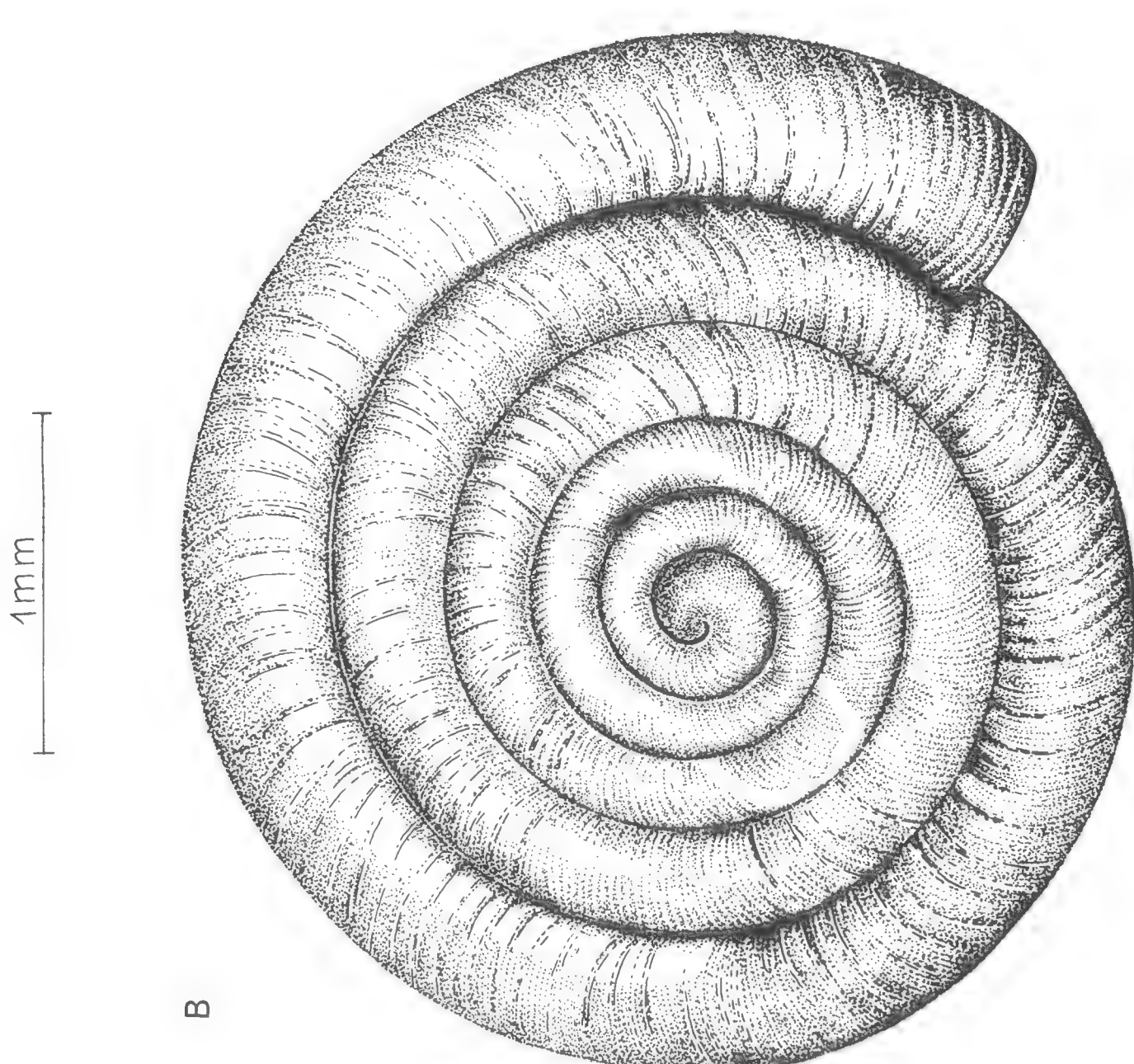
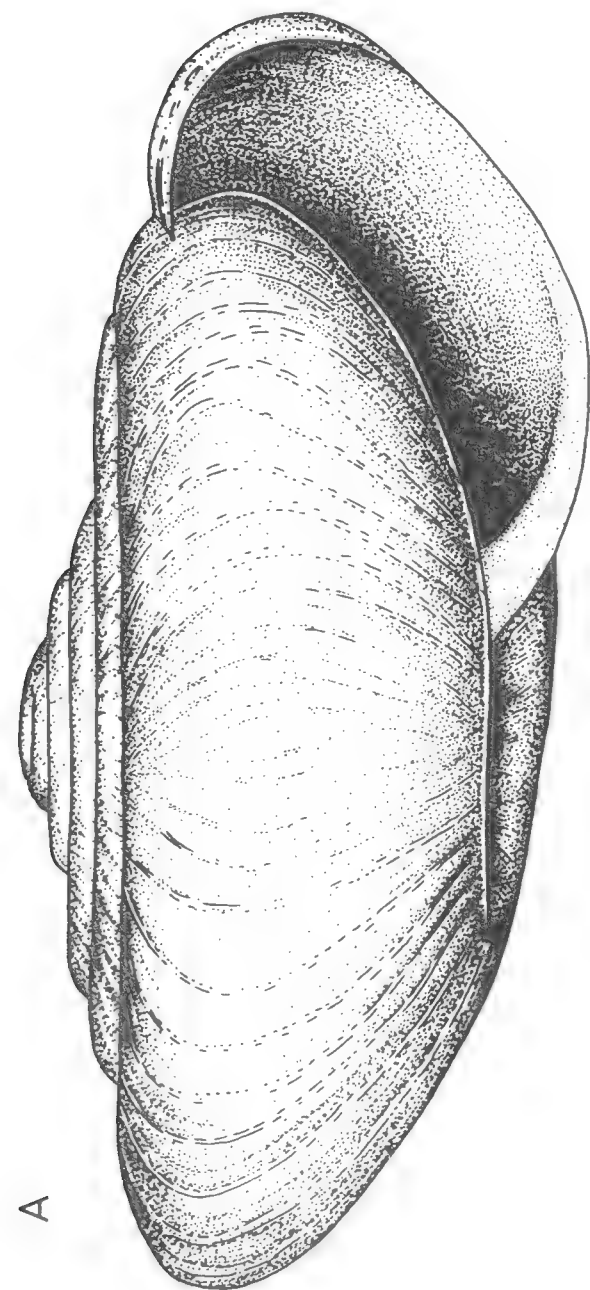
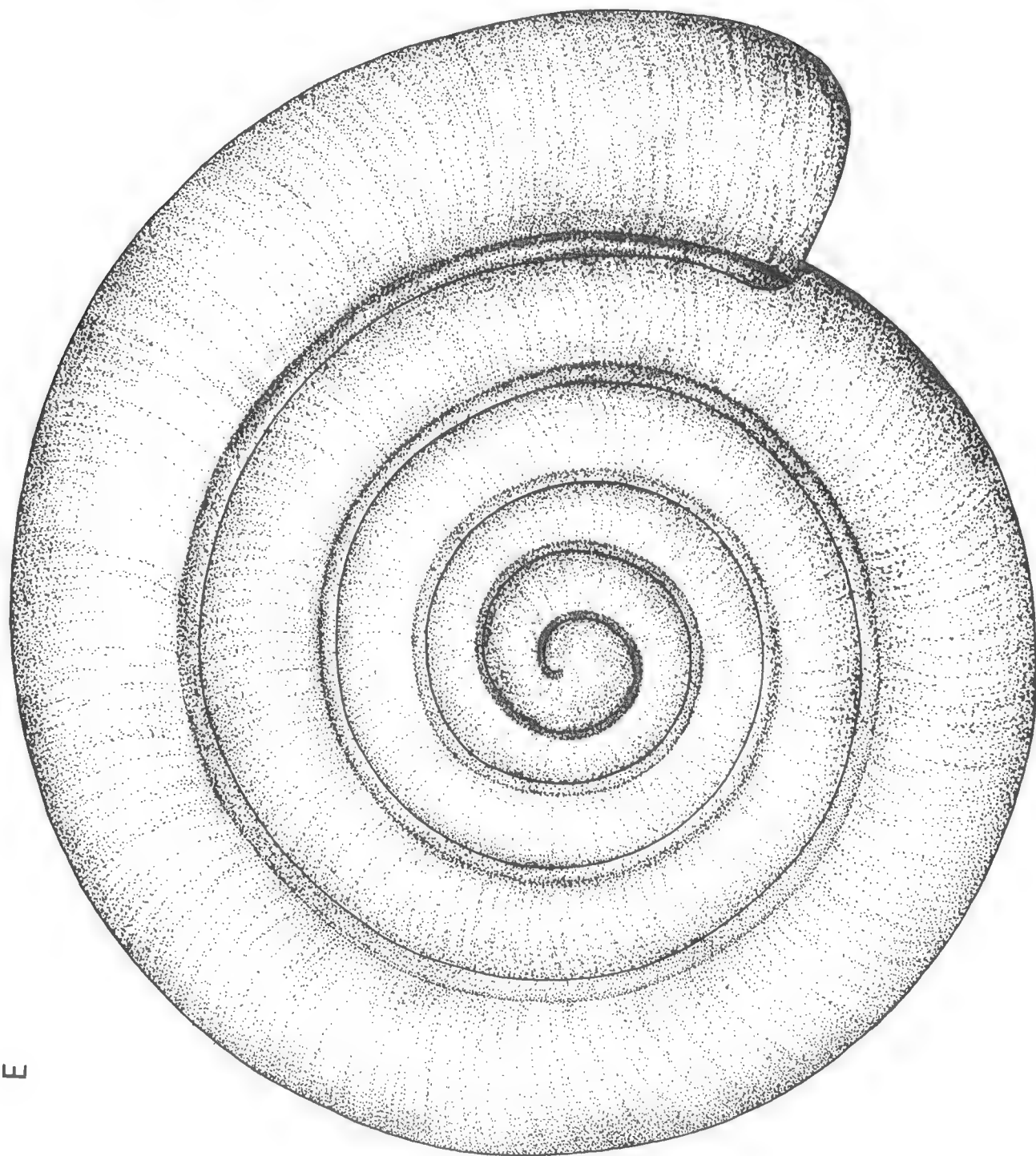
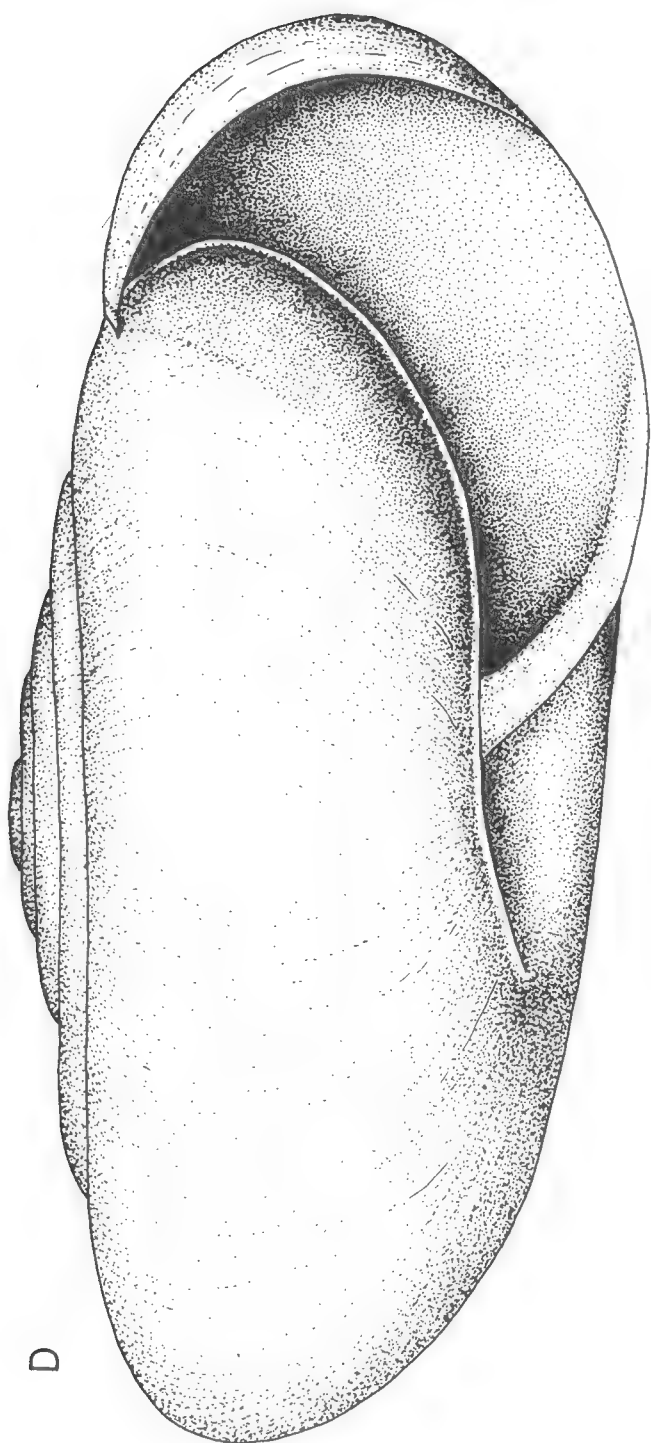


Fig. 1. Distribution map of *Vitrea* spp. in Ibiza. Inset map shows type locality of *V. striata* sp. nov.

¹ Department of Natural History, Leeds City Museums, LS1 3AA, England.

² Department of Earth Sciences, Liverpool University, L69 3BX, England.

³ Institute of Zoology, Polish Academy of Sciences, Warsaw, Poland.



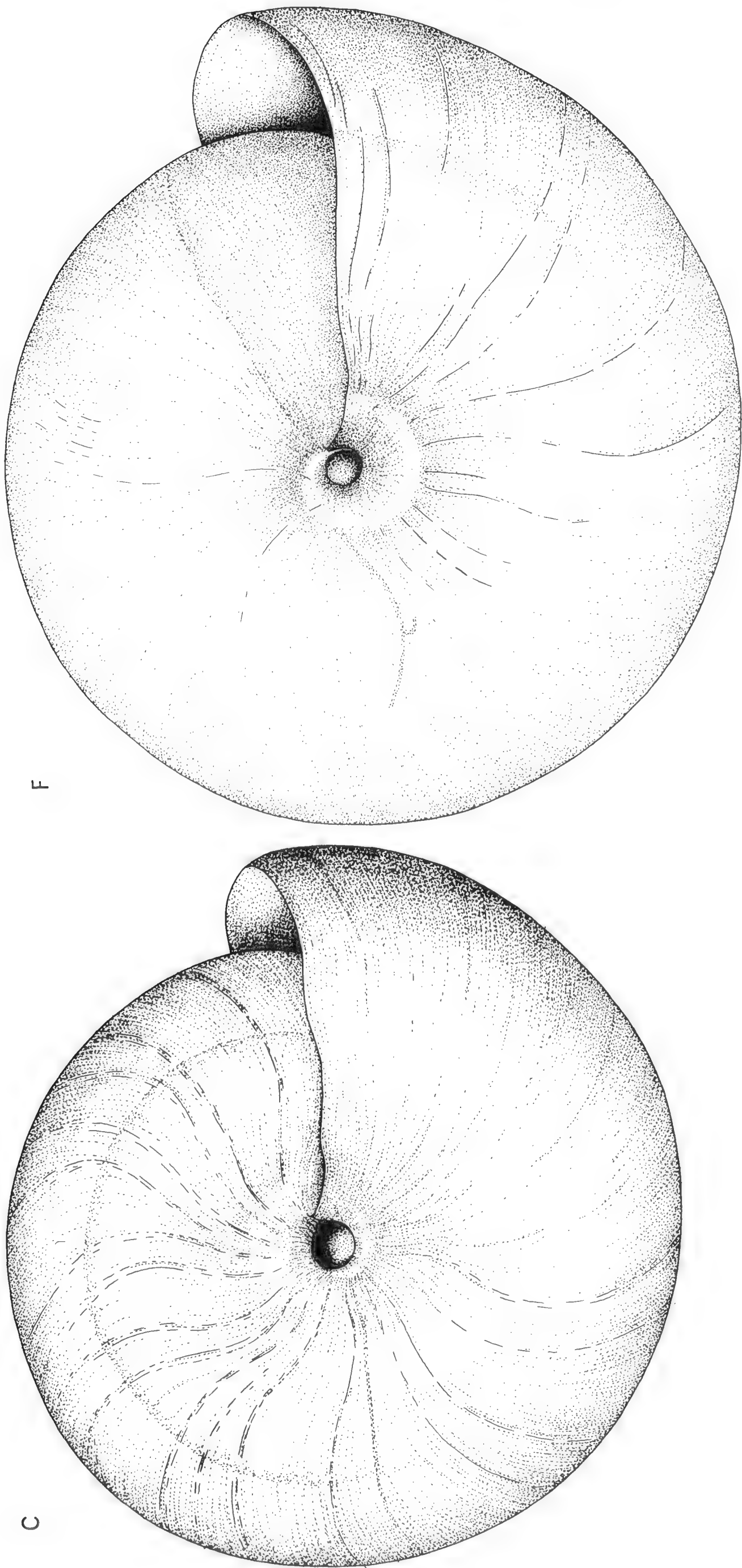


Fig. 2. Shells of Ibizan *Vitrea* spp. a-c *V. striata* sp. nov., paratype, Cala Sant Vicens, Ibiza, IZPAS coll. d-f *V. gasulli* Riedel & Paul 1978, holotype, Santa Eulalia del Rio, Ibiza, IZPAS coll.

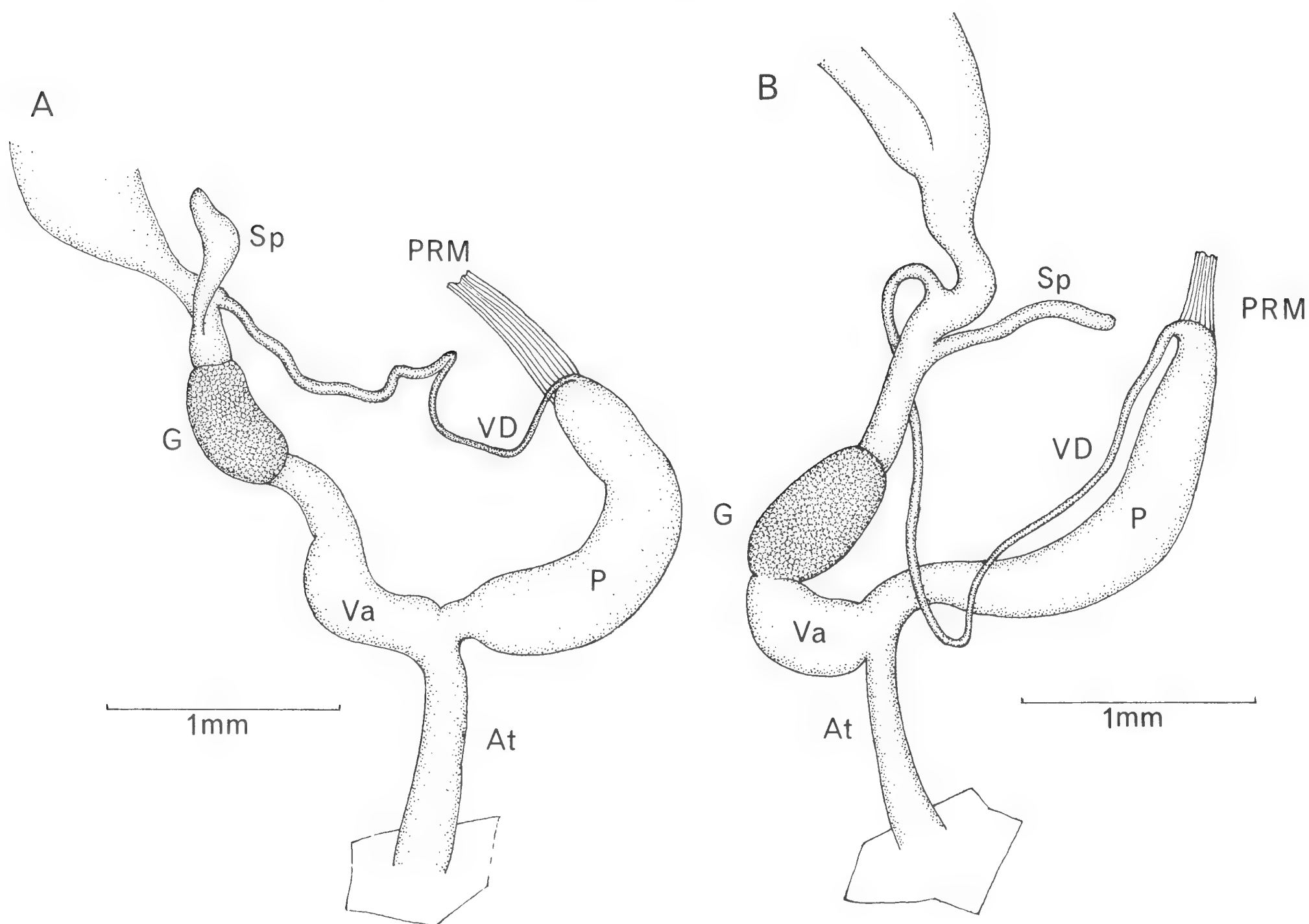


Fig. 3. Genital anatomy of Ibizan *Vitrea* spp. a *V. gasulli* Riedel & Paul 1978, Cala d'Aubarca, Ibiza. b *V. striata* sp. nov. Cala Sant Vicens, Ibiza. At atrium, G gland, P penis, PRM penial retractor muscle, Sp spermatheca, Va Vagina, VD vas deferens.

species, *Vitrea gasulli*, which Riedel and Paul (1978) described on shells alone. We are thus able to present here descriptions of the new species and, for the first time, the anatomy of *V. gasulli*.

***Vitrea striata* sp. nov.** (Figs. 2a–c, 3b)

Diagnosis: A species of *Vitrea* with a moderate-sized, perforate shell; $5\frac{1}{2}$ high shouldered whorls with an angular periphery and ornamented with very distinct, irregular, radial striae.

Description: Shell (Figs. 2a–c) of medium size for a species of *Vitrea*, up to 3.7 mm diameter, with a spire slightly, but distinctly raised in step-like whorls. The $5\frac{1}{2}$ narrow whorls are tightly coiled, distinctly flat above and separated by a moderately impressed suture. They increase slowly, but the last is 1.5 times as wide as the penultimate. The underside of the whorls is strongly curved especially in the centre of the shell near the umbilicus. The latter is small and only about $\frac{1}{20}$ of the shell diameter. It does not reveal the inner whorls. The whorls are flattened above and tumid below so their profile, although lacking a keel, is distinctly angular and shouldered. As a result the aperture is very narrow, crescent-shaped, and with a short upper and outer lip, but a long, weakly reflected basal and columellar lip. The shell is glassy, the embryonic whorls smooth and shiny, but later whorls have very strong and slightly irregular striations, especially on the last whorl. Striation is weaker on the under side.

Anatomy (Fig. 3b). Distal genitalia consist of a long thin atrium which divides into a penis and vagina of equal length. The penis is crescentic and internally it bears short spikes and cushion-like folds. The vagina is enveloped by a gland in its middle third, the lower third being distinctly thicker than the upper. A long, narrow, cylindrical spermatheca is inserted just below the point of departure of the vas deferens. Thus the free oviduct is very short and of almost the same diameter as the upper part of the vagina.

Type locality: foot of cliffs, south side of Cala Sant Vicens, Ibiza (Spanish Grid 378 4326). *V. striata* is only known from the type locality.

Holotype: British Museum (Natural History), London (BMNH) 1987-061. Paratypes: One shell and five examples in spirit, BMNH 1987-062, Institute of Zoology, Polish Academy of Sciences (IZPAS) 2 adults and 3 juveniles; and additional shells in the authors' collections.

Remarks

The shell of *V. striata* nov. is very distinctive in both the angular, high-shouldered whorls and the strong radial striation. The only described species of *Vitrea* with similar striations is *V. keana* Riedel & Mylonas, from the Greek island of Kea, but this differs in the general shape of the shell and it has rounded whorls. *V. striata* differs from the only other *Vitrea* known from Ibiza, *V. gasulli*, in that the latter has an almost smooth shell, without a step-like spire and with whorls that have a much more evenly rounded periphery (cf. Figs. 2a and 2d). Too few dissections have been performed to be certain of the diagnostic features of either species. However, *V. striata* has genital anatomy typical of the genus *Vitrea*. It appears to be characterized by having a gland enveloping the centre of the vagina, a long thin spermatheca, and fewer spikes within the penis than *V. gasulli*. Both Ibizan species have tiny spikes inside the penis, but the presence of such spikes has been documented in too few species to say whether they are characteristic of the genus *Vitrea*, or only certain species.

***Vitrea gasulli* Riedel & Paul, 1978 (Figs 2d-f, 3a)**

1978 *Vitrea gasulli* Riedel & Paul, p. 54, pl. 1.

1979 *Vitrea gasulli* Riedel & Paul, Gasull. p. 15, fig. (p. 16).

Diagnosis: A species of *Vitrea* with a moderate-sized, perforate shell, and $5\frac{1}{4}$ almost smooth, shouldered whorls.

Description: Anatomy (Fig. 3a). Distal genitalia with a long atrium, vagina slightly longer than the penis. Penis crescentic, internally bearing short spikes above and a moderately large fold below. The vagina tapers slightly upwards and is surrounded by a gland near its top. The spermatheca has a distinct terminal swelling and is elongate pyriform overall. It separates from the vagina just below the point of departure of the vas deferens, so again the free oviduct is very short and almost the same diameter as the upper vagina.

Representative spirit material (two examples from Cala d'Aubarca and two from Santa Eulalia) has been deposited in the BMNH 1987-063. The holotype (Figs 2d-f) is in IZPAS collections.

Type locality: Santa Eulalia del Rio, Ibiza.

Distribution: (Fig. 1). *V. gasulli*, like most other endemic species, is fairly widespread in Ibiza. *V. striata* in contrast is apparently confined to Cala Sant Vicens. This distribution is interesting in that *Pomatias elegans* is also confined to the immediate surroundings of Cala Sant Vicens (Gasull, 1964, fig. 25) and gives the impression of being a recent introduction to the island. It was first detected there in 1947 (Paul, 1982, p. 81) and seems to have spread very little from the original locality. It is just possible that *V. striata* is also an introduced species, but if so, we have no idea of its possible origin.

ACKNOWLEDGEMENTS

We wish to thank Mrs T. Buszko for the excellent drawings of the shells of Ibizan *Vitrea* and Joe Lynch for assistance in drafting Fig. 1.

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COMMUNICATIONS

LOCOMOTION OF *TRUNCATELLA SUBCYLINDRICA*

The small, rare and local prosobranch *Truncatella subcylindrica* L., is restricted to specialised high shore situations where it is always moist and frequently immersed in sea water. When out of water it has an unusual mode of progression resembling that of a looper caterpillar, described by Fretter and Graham (following Morton) as follows: 'The snail attaches itself with the foot and extends the snout, gripping the substratum with the terminal disk which is swollen by blood until it is not much less than the foot in area. By contraction of the columellar muscle the shell is pulled forwards so that the centre of gravity lies over the head; the foot is then released and re-attached immediately behind the oral disk' (Prosobranch Molluscs of Britain and Denmark, *suppl.* 5, *J. mollusc. Stud.* (1978), p. 140).

In animals from The Fleet in Dorset which I have watched, the foot has a considerably larger area than the swollen snout disk, being about 1 mm diameter as against rather more than $\frac{1}{2}$ mm diameter (both are very variable in shape and only roughly circular) for a shell length of $4\frac{1}{2}$ mm, and the snout is often not adherent while the shell is pulled forward. It seems that most of the grip needed to advance the shell is provided by the foot.

Fretter and Graham continue: 'Pilsbry (1948) stated that snails immersed in water moved in the ordinary gliding manner of prosobranchs, but neither he nor we have seen this happen'. Those snails which I have observed moving under water do not 'glide'. The front and rear halves of the foot are alternately extended and contracted, a 'hump' forming in the middle as the rear half is brought forward. I have not been able to see whether any part of the foot is lifted, but the impression is of a gap under the 'hump'. The snout reaches forward and the disk dilates but does not seem to grip the substrate, acting rather as a prop; neither this nor the advance of the shell are synchronised with the foot movements or with each other.

D. R. SEAWARD

Barn Court, Hamlet, Chetnole, Sherborne, Dorset, DT9 6NY.

(Received, 26th May, 1987)

ARION LUSITANICUS (?) ON THE FALKLAND ISLANDS

A slug, probably belonging to *Arion lusitanicus* (Mabille), was found near the cemetery of Port Stanley, Falkland Islands, March 25th 1986 by the Falkland–South Georgia expedition (Brood et. al. *Fauna och Flora* 82 (1987), pp. 1–48) of the Swedish National Museum of Natural History (Stockholm).

There are no earlier records of anthropochorously dispersed slugs reported from the Falklands neither in the papers by Quick (*Proc. Malac. Soc.* 29 (1952), pp. 181–189, *Bull. Brit. Mus. Nat. Hist.* 6 (1960), pp. 103–226), nor in more recent publications.

The identification of the specimen met with some difficulties as the anterior part, including the lower part of the genital apparatus, was severely damaged. According to external characters I consider it a subadult *A. lusitanicus*. The slug has also been examined by Prof. A. Wiktor, Wroclaw, Poland and Miss S. M. Davies, S. Croydon, Surrey. Prof. Wiktor agreed on the determination *A. lusitanicus*, whereas Miss Davies considered that although this might be correct, the slug also showed some affinities to *Arion subfuscus* (Draparnaud). Furthermore, recent research by Miss Davies has shown that in Britain *A. lusitanicus* has included one more species (*Arion flagellus* Collinge, see *J. Conch. Lond.* 32 (1987) pp. 339–354). It is also possible that still other forms may be present in this complex on the Continent. Thus further material from Port Stanley is necessary for providing a definite answer to which species is present.

It is very difficult to establish the correct time of introduction. Most probably it took place after the movement of the capital to Port Stanley in 1842. *A. lusitanicus* has spread rapidly outside its native distribution in SW- and W-Europe by the aid of man during the last two decades. It has been recorded under clearly synanthropic conditions in Algeria, Italy, Yugoslavia, Bulgaria, Switzerland, Austria, Western Germany and Sweden. Seen from this viewpoint, when much of the spreading has taken place during recent years, it is even possible that the occurrence on the Falklands is of a rather late origin.

I would like to thank Prof. A. Wiktor and Miss S. M. Davies for examining and giving their opinions on the slug and Dr. N. J. Evans, British Museum (Natural History) for checking the literature and giving other valuable assistance.

T. VON PROSCHWITZ

Natural History Museum Box 7283, S-40235 Göteborg, Sweden

(Received, 10th June, 1987)

FURTHER NOTES ON *VALLONIA ENNIENSIS* IN FRANCE

Following our article entitled Collecting Molluscs around Reims, France (*The Conchologist's Newsletter* June 1986), we are now able to report further references and new French localities for shells of *Vallonia enniensis* (Gredler, 1856).

The earliest French record is that of Sterki 1893 (*Proc. Acad. nat. Sci. Philadelphia*, (1893) pp. 234–281) who recognised *V. pulchella* var. *enniensis* mixed with *V. costata* in a tube of specimens from Grasse, Alpes Maritimes, France, in the collections of the Academy of Natural Sciences, Philadelphia. Of the shell, Sterki says 'The striae are very strong, but the other characters of the shell are those of *V. pulchella*'. Sterki's French record was later referred to by Germain in 1933 (*Faune de France* **21**, Mollusques terrestres et fluviatiles); Ehrmann in 1956 (*Die Tierwelt Mitteleuropas*, Leipzig) and Zilch and Jaeckel in 1962 (*Die Tierwelt Mitteleuropas*, Brohmer, Ehrmann and Ulmer). In western Europe there is a recent account of specimens from Valencia, Spain by Gasull (*Bol. Soc. Hist. nat. Baleares* **20** (1975) pp. 5–155). The snail atlas for Belgium (Edited by de Wilde, Marquet and van Goethem, 1986) shows one locality for this species based on dead shells collected before 1950.

Further records of *Vallonia enniensis* collected by one of us (C.S.) are now available for marshes in the Reims area in northern France, and these are as follows:

1. Cormontreuil, a small marsh on the south-east fringe of Reims. UTM reference EQ 785530.
2. Champigny, 8 km west of Reims – a locality described previously in Chatfield and Stévanovitch (1986). UTM reference EQ 690589.
3. Trigny, close to our original locality at Courcelles-Sapicourt. UTM reference EQ 643593.
4. Jalons, marshy ground 25 km south-east of Reims on the Somme-Sonde river which flows into the Marne. UTM reference EQ 872293.
5. Avenay in the Mountain of Reims, the river a tributary of the Marne. UTM reference EQ 776369.
6. Vert-la-Gravelle, 'marais de St Gond', a large area of marshy ground some 50 km south of Reims. UTM reference EQ 676106.
7. Laheycourt, 70 km to the east in the neighbouring Department of Meuse. UTM reference FQ 490160.

The shells were collected by sifting earth and leaf litter from marshy sites but no living specimens were found. Field work showed that *V. enniensis* was neither abundant nor frequent in its occurrence although specimens were collected over a wide area and up to 70 km from Reims. They were found in marshy areas along the river systems of the Vesle and the Marne as well as in isolated marshes.

Further shells of *V. enniensis* have been found in recent years by Monsieur Frédéric Magnin (Pers. comm.) from several stations in the region of Aix-en-Provence in the south of France and he also reports finding it in sub-fossil deposits of Holocene age in the same area. Again, no living animals have been found, but further investigations are in progress.

Vallonia enniensis is a snail of marshy places and is found alive in eastern Europe. Kerney and Cameron in *A Field Guide to the Land Snails of Britain and North-west Europe* (Collins, 1979) give its distribution as Hungary, Czechoslovakia and parts of Austria. It is known as a fossil from a wider area in Europe, including the south of France. It is possible that the specimens from Reims may have been washed out of fossil deposits. This snail should be searched for in suitable marshy habitats to see whether it is an overlooked member of the present day fauna or whether it is derived entirely from reworked fossil material. The shell resembles *V. costata* in having axial ribs, but in *V. enniensis* the ribs are closer together. These species are illustrated in the field guide by Kerney and Cameron (1979).

We are most grateful to Dr. David Holyoak and Monsieur Frédéric Magnin for pointing out additional references and localities.

JUNE E. CHATFIELD¹ AND COLETTE STÉVANOVITCH²

- 1.) The Oates Memorial Library and Museum and The Gilbert White Museum. The Wakes, Selborne, Alton, Hampshire GU34 3JH and 2.) 60 Esplanade Fléchambault, 51100 Reims, France.

(Received, 28th August, 1987)

A SECOND BRITISH INTERGLACIAL RECORD OF *MARGARITIFERA AURICULARIA*

Margaritifera auricularia (Spengler), a large freshwater mussel, was first recorded in Britain from calcreted gravel that had been dredged from the Thames at Mortlake (Jackson & Kennard, *J. Conch.*, Lond. **12** (1909) pp. 321–322). Subsequent dredging produced many additional specimens from various places between Mortlake and Battersea. These fossils were said to have been associated with Neolithic implements, including polished stone axes (Kennard, *Proc. malac. Soc. Lond.* **15** (1923) pp. 241–259) and recent radiocarbon dates on the shells

COMMUNICATIONS

themselves have supported this age assignment (Preece *et al.*, *J. archaeol. Sci* **10** (1983) pp. 249–257).

M. auricularia is also known from much earlier Thames deposits. Several specimens of it were recovered from fluviatile sands exposed in excavations below Trafalgar Square in 1957–8 (Kerney, *J. Conch., Lond.* **24** (1958) p. 250). The associated fauna included *Belgrandia marginata*, *Potamida littoralis* as well as *Hippopotamus amphibius*. The palaeontological evidence clearly indicated an Ipswichian (Last) interglacial age.

A second British interglacial occurrence of *M. auricularia* can now be put on record. At Purfleet, Essex, interglacial fluvial deposits are exposed in two chalk quarries known as Bluelands (TQ 570797) and Greenlands (TQ 568785). Pleistocene deposits at the latter site rest on Chalk (surface between 6 and 7 m OD) and are precariously perched above a sheer chalk cliff making access extremely hazardous. The stratigraphy here has been described in detail by Hollin (*Boreas* **6** (1977) p. 38). The *M. auricularia* came from the base of the 'Laminated Beds' in a unit of shelly sand rich in calcium carbonate concretions ('race'). Many of these concretions have encased the shells of freshwater mussels which have subsequently dissolved leaving internal moulds. The *M. auricularia* occurred in such a state but left no doubt as to its specific identity. The associated molluscan fauna has been described by Snelling (*Essex Nat.* **33** (1975) pp. 104–80). The fauna is characteristic of a large temperate river. The presence of some brackish-water ostracods (e.g. *Cyprideis torosa*) and fish such as the sturgeon (*Acipenser*), together with the distinctive laminations, indicate tidal influence (cf Hollin *op. cit.* Allen, *Quat. Newsl.* **22** (1977) pp. 1–3).

Opinion is divided as to the precise age of the interglacial deposits at Purfleet and indeed several other interglacial sites in the Lower Thames. However there is general agreement that the Trafalgar Square deposits are Ipswichian. Although there are faunal similarities between this site and Purfleet, there are some striking differences. For example, *Corbicula fluminalis* is abundant at Purfleet but entirely lacking at Trafalgar Square in what appears to have been a similar depositional environment. Amino acid ratios (Miller *et al.*, *Nature* **281** (1979) pp. 539–543) from Purfleet are also significantly higher than comparable ratios from Trafalgar Square, suggesting an earlier age. Moreover the gravels overlying the fossiliferous sands at Purfleet have yielded Acheulian artefacts (Palmer, 1975, *Essex Archaeol. & Hist.* **33** (1975) pp. 104–8) although these may have been reworked. Precise dating of the Purfleet sequence must therefore await further work.

I am extremely grateful to Mr John Clayden, who found this interesting fossil and who placed it at my disposal. It has now been lodged in the University Museum of Zoology, Cambridge.

R. C. PREECE

Department of Zoology, University of Cambridge CB2 3EJ

(Received, 29th September, 1987)

VERTIGO MODESTA, A SNAIL NEW TO THE BRITISH ISLES

On 13th June, 1987, during a search for molluscs on Geal Charn (south Inverness-shire) several specimens of a *Vertigo* species were discovered which proved to be *Vertigo modesta* (Say, 1824), a species not previously recorded in Britain.

The site where the *V. modesta* were found was at 980 m on a limestone outcrop, on a north-east facing slope. The snails (5 of which were live) were discovered at 2 sites approximately 50 m apart. The first site was a short turf rich in arctic alpine comprising *Salix reticulata* L., *Dryas octopetala* L., *Saxifraga oppositifolia* L., *Polygonum viviparum* L., *Armeria maritima* (Miller) Willd., *Alchemilla alpina* L., *Silene acaulis* (L.) Jacq., *Thalictrum alpinum* L., *Veronica fruticans* Jacq., *Saxifraga aizoides* L., *Ranunculus acris* L., the lichen *Peltigera* sp. and the mosses *Dicranum scoparium* Hedw., *Rhytidiadelphus triquetrus* (Hedw.) Warnst., *Racomitrium canescens* (Hedw.) Brid., and *Hylocomium splendens* (Hedw.) Br. Eur.

The second site was an ungrazed ledge with a somewhat taller growth dominated by the rare arctic willow *Salix lanata* L. Other plants present were *Cerastium alpinum* L., *Saxifraga hypnoides* L., *S. oppositifolia*, *D. octopetala*, *A. alpina*, *S. acaulis*, *A. maritima*, *Vaccinium myrtillus* L., *P. viviparum*, *Coeloglossum viride* (L.) Hartmann, and the mosses *R. canescens*, *H. splendens* and *D. scoparium*.

The height at which the specimens of *modesta* were found is close to the maximum height at which Waldén (*Arch. Moll.* **117** (1986), pp. 39–59) records *V. modesta arctica* from Scandinavia. Although the climates are not directly comparable because of the effects of latitude and exposure, it is clear that *modesta* in Britain inhabits an area with a very severe climate – and may well be restricted to such areas. The other molluscs present – *Arianta arbustorum*, *Vitrina pellucida* and *Euconulus fulvus* – are all species that are likewise recorded up to 1000 m in Scandinavia (Waldén, *op. cit.*) and at high altitude on Ben Lawers by Dance, *J. Conch.* **27** (1972), pp. 509–515 (*A. arbustorum* and *V. pellucida* up to 3,800 ft (1154 m) and *E. fulvus* up to 2,500 ft (759 m)).

It is interesting that the present discovery of *V. modesta* is associated with the dwarf willows *S. lanata* and *S. reticulata* which are themselves part of a relict arctic flora restricted in Britain to 25 and 11 10 km squares respectively (Perring and Walters, *Atlas of the British Flora*, 1976).

It is surprising that *V. modesta* has not been found as a fossil in deposits of the cold stages of the Quaternary in Britain (Holyoak, pers. com.).

We should like to thank Dr. M. P. Kerney and Dr. D. T. Holyoak for confirming the identification and for drawing our attention to Waldén's paper.

R. W. AND DOROTHY K. MARRIOTT
14 View Terrace, Aberdeen AB2 4RR.
(Received, 6th October, 1987)

INTERNATIONAL TRUST FOR ZOOLOGICAL NOMENCLATURE

Bulletin for Zoological Nomenclature, Volume 44, Part 1, 23 March 1987.

APPLICATIONS

Comment or advice on these applications is welcomed for publication in the *Bulletin* and should be sent to the Executive Secretary, ICZN, c/o British Museum (Natural History), London SW7 5BD, U.K.

Case 2563

Conus floridanus Gabb, 1869 (Mollusca, Gastropoda): proposed conservation of the specific name.

W. O. Cernohorsky

Auckland Institute and Museum, Private Bag, Auckland 1, New Zealand.

Abstract. The purpose of this application is the conservation of the widely accepted marine prosobranch name *Conus floridanus* Gabb, 1869 by the suppression of an unused senior subjective synonym, *Conus anabathrum* Crosse, 1865.

Case 2548

Harpa articularis Lamarck, 1822 (Mollusca, Gastropoda): proposed conservation of the specific name.

Harald A. Rehder and Richard E. Petit.

Department of Invertebrate Zoology, National Museum of Natural History, Smithsonian Institute, Washington, D.C. 20560, U.S.A.

Abstract. The purpose of this application is to conserve the well known harp shell name *Harpa articularis* Lamarck, 1822, which is threatened by the unused senior synonyms *Harpa delicata* and *Harpa urniformis* Perry, 1811.

OPINIONS AND DIRECTIONS

Direction 119

Tornatellina Pfeiffer, 1842 (Mollusca, Gastropoda): Official List entry completed.

Bulletin of Zoological Nomenclature, Volume 44, Part 2, 25 June 1987.

OPINIONS

Opinion 1436

HARPIDAE Hawle & Corda, 1847 (Trilobita) and HARPIDAE Bronn, 1849 (Mollusca, Gastropoda): a ruling to remove the homonymy.

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Journal of Conchology

Vol. 33, Part 1, May 1988

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SYSTEMATICS AND BIOGEOGRAPHY OF SOME WESTERN EUROPEAN *CLAUSILIA* (GASTROPODA: CLAUSILIIDAE)

D. T. HOLYOAK¹ AND MARY B. SEDDON¹

(Accepted for publication, 20th February, 1988)

Abstract: *Clausilia rugosa* has often been regarded as a form of *C. bidentata* because of close similarities in shell form. However, in genital anatomy *rugosa* closely resembles *parvula* in having a long slender loop of penial epiphallus, a character in which both of these differ from all other *Clausilia* species including *C. bidentata*. Mapping of the ranges of *parvula* and *rugosa* has disclosed that they never coexist; studies of shell variation reveal that they are connected through the occurrence of populations with intermediate shells. They are therefore regarded as conspecific and should be known as *C. rugosa rugosa* Draparnaud, 1801 and *C. rugosa parvula* Férussac, 1807. In southern France *C. bidentata* coexists locally with varied populations of *C. rugosa*, without any evidence of hybridisation. On the basis of anatomical study of large numbers of populations the geographical ranges, patterns of shell variation and habitat preferences are described for *C. rugosa* and *C. bidentata*. It is suggested that self-fertilisation may account for maintenance of some of the local population variants in these species, but studies of population genetic structure are needed to test this. Explanations are offered for the adaptive significance of regional variations in shell size, shape and ribbing. The geographical ranges, habitat preferences and distributional history of all species of *Clausilia* (*Clausilia*) are compared. Ecological factors involved in the wider range expansion of *C. bidentata* than of *C. rugosa* during Post-glacial (and several Pleistocene interglacials) are discussed.

INTRODUCTION

Early in the last century the wide variability in shell form led to the recognition of large numbers of *Clausilia* species allied to *C. bidentata* Ström, 1765. Adolf Schmidt (1857) brought order to these long lists of nominal species by separating *C. pumila*, *cruciata*, *dubia*, *parvula*, *nigricans* (= *bidentata*) and *rugosa* as valid species and synonymising nearly all of the rest as forms and varieties. Despite much further multiplication of species names by French workers of the 'Nouvelle Ecole' in the latter part of the nineteenth century (e.g. Bourguignat 1876–1877, Locard 1882, 1894), Schmidt's rather parsimonious treatment has mainly been followed, both in influential regional works (e.g. Favre 1927, Ehrmann 1933, Kerney & Cameron 1979) and in systematic studies specialising on Clausiliidae (e.g. Nordsieck 1963, 1979, 1984).

Uncertainty has nevertheless continued over the status of forms from Italy, southern France and northern Spain. The similarity in shell characters has made it unclear whether *rugosa* should be regarded as a southern form of *C. bidentata* or as a distinct species (cf. Kerney, Cameron & Jungbluth 1983, p. 298).

Critical anatomical comparisons involving *rugosa* have only been made in the past few years. Gittenberger & Ripken (1981) figured the genitalia of *andusiensis*, a conchologically distinctive form from Anduze in southern France which they treated as a distinct species. These authors showed that this form has a long slender loop of penial epiphallus much as in *C. parvula* (cf. Nordsieck 1963, 1966) and the Italian form *pinii* (cf. Giusti & Mazzini 1970) and different to the short thick epiphallus of *bidentata* (cf. Steenberg 1914, Polinski 1928) and of the form *crenulata* from Alpes Maritimes (Gittenberger & Ripken, *op. cit.*, p. 176). Soon

¹ School of Geography and Geology, College of St. Paul and St. Mary, The Park, Cheltenham, Glos. GL50 2RH

afterwards, Gittenberger (1982) described the genital anatomy of topotypical *rugosa* from Montpellier and found that it was very similar to that of *andusiensis*, which he therefore treated as a subspecies of *C. rugosa*. He reiterated the similarity in genital anatomy of *parvula* and *rugosa* and, while treating them as distinct species, suggested they form a single 'Rassenkreis'. Nordsieck (1984) commented that Schmidt's conception of *rugosa* was incorrect and that the true *rugosa* from Languedoc and Catalonia is closely related to *parvula* and *pinii*, with which it may be conspecific; he noted that the forms *pyrenaica* and *crenulata* belong with *bidentata*.

This paper reports a study of the geographical ranges, habitat preferences, shells and genital anatomy of *Clausilia* from most regions of western Europe. Extensive material from France supports Nordsieck's (1984) suggestion that *rugosa* and *parvula* are conspecific. We describe results of a mapping study based on the U.T.M. grid to clarify the distribution patterns of these forms and of *C. bidentata*. Comments are also made on the subspecific variation of shells of these taxa and on possible ecological correlates of the variation.

STRUCTURE AND FUNCTIONING OF THE TERMINAL MALE GENITALIA

Steenberg (1914) provided the first accurate and detailed accounts of the genital anatomy of *Clausilia bidentata*, *C. dubia* and *C. pumila* and Poliński (1928) made a careful comparison of *C. bidentata* and *C. dubia*. These three species were found to have very similar genital morphology. Nordsieck (1963, 1966) described the genital anatomy of *C. cruciata*, *C. parvula* and *C. whateliana* (a localised endemic of the Italian Alps). He found that the anatomy of *cruciata* was generally similar to that of *C. bidentata*. *C. whateliana* was found to differ from other *Clausilia* in having a proportionately small penis and the penial retractor muscle inserting a short distance along the epiphallus ('parepiphallus') rather than inserting on both the penis and the epiphallus near their junction (cf. Fig. 1); this difference led Nordsieck (1977) to separate *C. whateliana* subgenerically as *Clausilia (Strobiliella)*. Nordsieck's (1963) description of the genital anatomy of *C. parvula* confirmed earlier studies (e.g. Mermoud 1930) in showing that the part of the epiphallus adjacent to the penis forms a long slender loop that is lacking in other *Clausilia* (cf. Fig. 1).

As described in the Introduction, more recent studies on *Clausilia* from southern Europe have shown that several other forms also have the slender loop of epiphallus that characterises *parvula* (*pinii*: Giusti & Mazzini 1970, *andusiensis*: Gittenberger & Ripken 1981, *rugosa*: Gittenberger 1982). However, other southern European taxa have been found to lack this loop and thus have terminal male genitalia much as in *C. bidentata* (*crenulata*: Gittenberger 1982; *pyrenaica*: Nordsieck 1984).

During the present study dissection of specimens from several hundred populations has confirmed that it is realistic to recognise a distinction between a *rugosa* type of male genitalia with slender epiphallus loop and a *bidentata* type that usually lacks the loop (or exceptionally, has a small loop). Immatures of the *rugosa* type have a proportionally shorter and less slender loop than mature individuals, but they are recognisable by the small overall size of their genitalia and weakly calcified peristome of the shell.

In both *rugosa* and *bidentata* types there is nonetheless a considerable range of variability within populations in the form of the penis and adjacent parts of the epiphallus, much but not all of which is likely to be related to the reproductive condition of individual snails. There are also apparently differences between populations in the length and thickness of the epiphallus loop (cf. Fig. 1), but these are likely to be partly attributable to differing reproductive states.

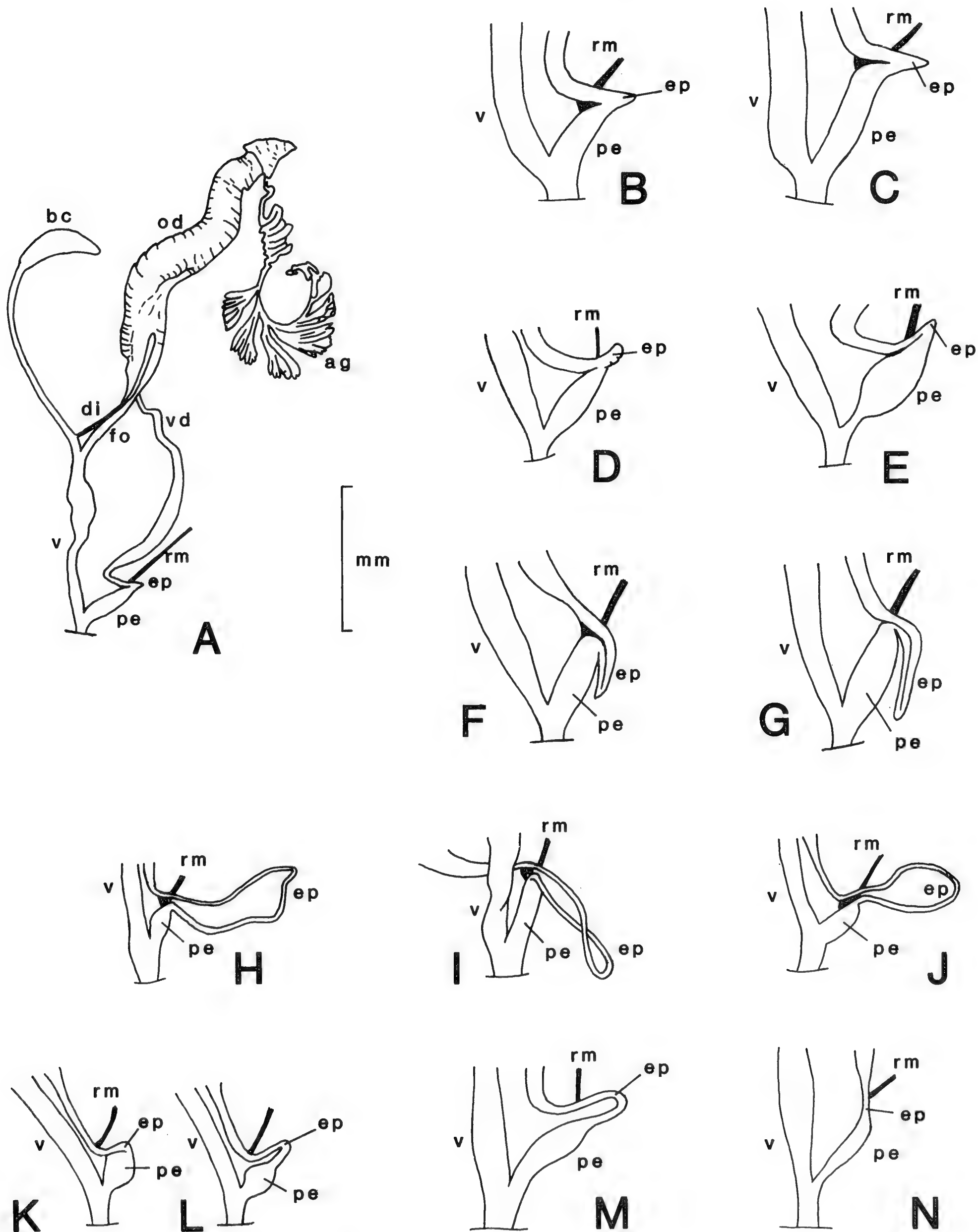


Fig. 1. Genital anatomy of *Clausilia* and *Neostyriaca*.

A Genitalia of *C. bidentata* (Berkshire, England); B–N terminal genitalia only.

B–E more or less typical *C. bidentata* (B Co. Donegal, Ireland; C Berkshire, England; D Prov. Logrono, Spain; E Prov. Santander, Spain); F, G *C. bidentata* with exceptional development of epiphallus loop (S. France); H *C. r. parvula* (Switzerland); I, J *C. r. rugosa* (I Pyrenées-Orientales, France; J Prov. Massa-Carrara, Italy); K, L *C. whateliana* (based on Nordsieck 1966, Abb. 28 a, c); M *N. corynodes* (based on Nordsieck 1966, Abb. 46 a); N *N. strobili* (based on Nordsieck 1966, Abb. 47 a). Scale line (drawings B–J only) represents 1.0 mm.

Abbreviations: ag albumen gland, bc buras copulatrix, di diverticulum, ep epiphallus, fo free oviduct, od ovispermiduct, pe penis, rm retractor muscle, v vagina, vd vas deferens.

A detailed functional interpretation of the significance of the difference in genital anatomy between the *rugosa* and *bidentata* types is not possible at present, but the following comments on the extent of ignorance of the reproductive biology of *Clausilia* may encourage further studies.

It is unclear how the long muscular section of the epiphallus functions but it presumably serves mainly to propel sperm into the penis. In mating the penis is thought to be everted by its intrinsic musculature and returned to the resting position of contraction of the penial retractor muscle. In *C. bidentata* the greater length of the penis than of the genital atrium implies that the everted penis should protrude well beyond the external genital opening to form an intromittent organ. In contrast, many individuals of the *rugosa* type have a penis that is shorter than the genital atrium and thus when everted it cannot protrude far outside the external genital opening. As in other Clausiliidae, the diverticulum and bursa copulatrix are presumed to function for storage of sperm and destruction of unused sperm (cf. Steenberg 1914). However, in all *Clausilia* the distance from the external genital pore to the entrance to the duct of the bursa is several times the length of the penis so there is no possibility of direct introduction of free sperm from the everted penis into the opening of the duct.

Sperm transfer in an elongated spermatophore is likely to be of general occurrence in Clausiliidae and a spermatophore has been reported in *Clausilia pumila* (Steenberg 1914, p. 25). If it is postulated that such a long spermatophore (as long as the thickened part of the epiphallus) is also produced in *C. bidentata* and *C. rugosa* it could reach from the everted penis of a mating partner into the opening of the duct of the bursa, providing a mechanism of sperm transfer. This long spermatophore would need to enter the penis through the adjacent slender portion of the epiphallus. Differences between *bidentata* and *rugosa* types in epiphallus structure could therefore be related to differences in size and structure of spermatophore, perhaps through the need to orientate a very long spermatophore during mating in the *rugosa* type.

These suggestions will remain speculative until the occurrence and characteristics of spermatophores are demonstrated for *C. bidentata* and *C. rugosa*. The absence of reports of them in the literature may not be significant as spermatophores are thought to dissolve quickly after mating in Clausiliidae, as in other pulmonate families such as Arionidae and Milacidae, and the few workers who have studied the genital anatomy of these *Clausilia* have probably not investigated closely the interior of the epiphallus and duct of the bursa. Further investigation is hampered by our failure to find mating individuals of *C. bidentata* and *C. rugosa*, as discussed below.

SHELL MORPHOLOGY

Most recent authors have separated *C. parvula* from *C. bidentata* on the basis of its smaller shell with much finer, less developed ribbing (Pl. 5). *C. rugosa* appeared much closer to *C. bidentata* in shell characters, differing in tending to have a proportionately more slender shell and somewhat coarser ribbing (Pl. 5). However, our collections from southern France include numerous population samples with shells intermediate in both size and ribbing between the *parvula* and the *bidentata/rugosa* types (cf. Pl. 5).

As described above, anatomical study has shown that *parvula* and *rugosa* have similar genital anatomy that usually differs markedly from that of *bidentata*. Here the variation in shell form is described for populations that we have studied anatomically. An attempt is then made to account for some of the regional and other variation in adaptive terms.

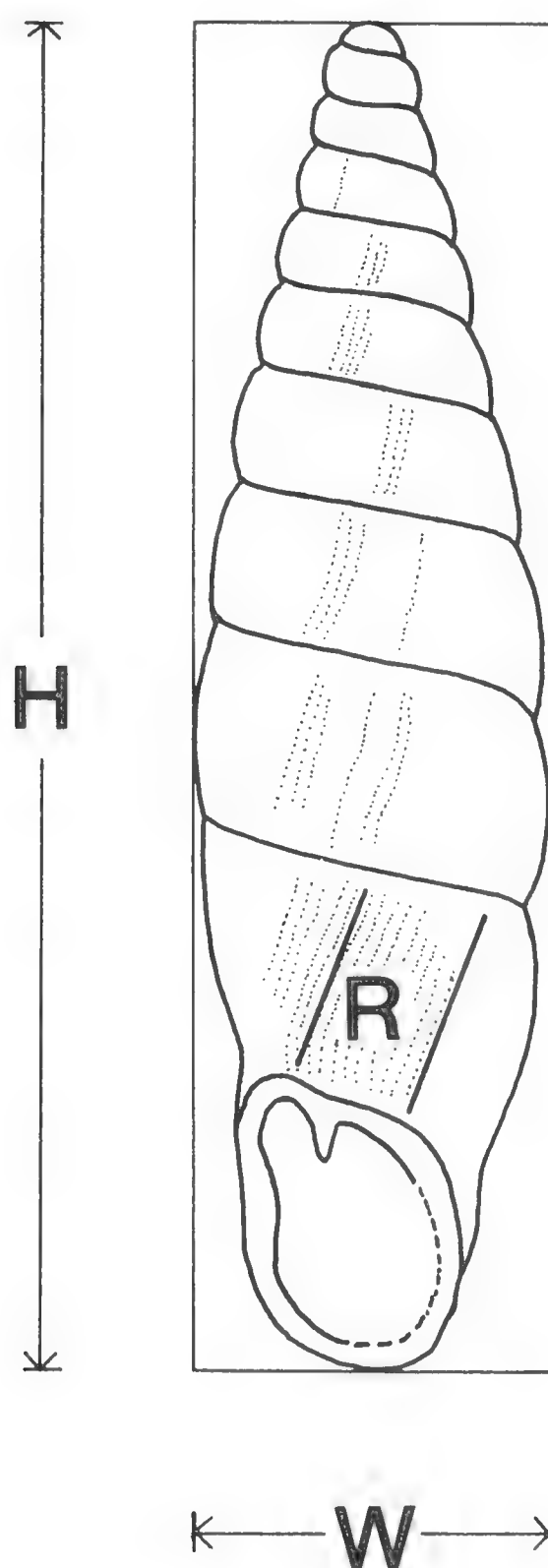


Fig. 2. Methods of measurement of shells of *Clausilia* spp.

H (shell height) and W (shell width) were measured to accuracy of ± 0.05 mm using callipers. Number of ribs (R) on 1.0 mm of body whorl (positioned between lines shown in drawing) was counted with aid of microscope drawing tube.

(1) *C. bidentata*

Series of population samples of about thirty shells of *C. bidentata* (verified anatomically) have been collected by us from most of the range, from arctic Norway southwards to Spain (Fig. 3). Measurements of shell height, breadth and ribbing (taken by methods summarised in Fig. 2) are presented for representative population samples in Table 1.

Considerable variability of shell height and breadth occurs both within and between local populations of *C. bidentata*. Boycott (1919, 1920, 1927, 1928) documented this variation in several Welsh populations and showed that differences of mean shell size between local populations are maintained year after year. Similar differences between local populations are evident in our data and they probably occur throughout the range of the species.

There are nonetheless certain broad regional trends in shell form that transcend this localised variability. The most conspicuous of these trends is for northern and high mountain populations to have short and proportionately broad shells, whereas southern lowland populations have longer and proportionately narrower shells (cf. Pl. 5). A comparable tendency for small squat shells to characterise forms living in cold places occurs

TABLE 1

Measurements of shells of representative population samples of *Clausilia bidentata* and *C. rugosa*. See Fig. 2 for methods of measurement. Measurements of shell height and width are in mm; rib counts are per 1.0 mm (see Fig. 2); \bar{x} = mean, s = sample standard deviation, NS = number of shells, NP = number of population samples, ASL = above sea level, * = excluding Pyrenees and Alpes-Maritimes, ** = excluding Pyrenees.

| Form/Region | Height | | Width | | Rib Count | | NS | NP |
|--|-----------|-----|-----------|------|-----------|-----|------|----|
| | \bar{x} | s | \bar{x} | s | \bar{x} | s | | |
| <i>C. BIDENTATA</i> | | | | | | | | |
| Norway (N. of 68°N.) | 9.8 | 0.7 | 2.78 | 0.13 | 17.7 | 3.1 | 476 | 28 |
| Norway (S. of 68°N.) | 9.7 | 0.6 | 2.67 | 0.14 | 15.4 | 2.9 | 760 | 40 |
| Sweden | 9.7 | 0.6 | 2.58 | 0.15 | 15.2 | 2.7 | 432 | 24 |
| Finland | 9.9 | 0.7 | 2.65 | 0.10 | 15.8 | 3.0 | 114 | 12 |
| Scotland | 10.4 | 0.8 | 2.55 | 0.17 | 13.2 | 3.1 | 287 | 10 |
| Ireland | 10.5 | 0.7 | 2.57 | 0.16 | 11.4 | 2.9 | 360 | 15 |
| England & Wales | 10.9 | 0.8 | 2.54 | 0.18 | 12.1 | 2.8 | 1425 | 57 |
| France (N. of 48°N.) | 10.8 | 0.7 | 2.56 | 0.17 | 12.4 | 2.9 | 744 | 31 |
| France (46°–48°N.) | 10.4 | 0.8 | 2.48 | 0.16 | 11.7 | 2.7 | 924 | 33 |
| France (S. of 46°N.)* | 10.7 | 0.8 | 2.38 | 0.19 | 11.0 | 2.6 | 528 | 24 |
| Pyrenees (<500 m ASL) | 11.2 | 0.9 | 2.38 | 0.18 | 11.4 | 2.7 | 330 | 15 |
| Pyrenees (500–1500 m) | 10.5 | 1.1 | 2.47 | 0.14 | 12.7 | 3.1 | 357 | 17 |
| Pyrenees (>1500 m) | 9.7 | 0.9 | 2.58 | 0.12 | 15.6 | 2.8 | 118 | 3 |
| N. Spain** | 10.3 | 0.9 | 2.54 | 0.17 | 10.4 | 2.3 | 506 | 22 |
| SE. France (Alpes-Maritimes) | 11.7 | 1.0 | 2.47 | 0.19 | 9.1 | 2.0 | 145 | 7 |
| <i>C. R. RUGOSA</i> | | | | | | | | |
| S. France | 10.1 | 0.7 | 2.35 | 0.15 | 10.2 | 2.4 | 1040 | 26 |
| around Anduze (Gard) | 10.5 | 0.8 | 2.36 | 0.13 | 7.1 | 2.0 | 171 | 5 |
| ['andusiensis'] | | | | | | | | |
| E. Pyrenees (large form) | 11.1 | 0.7 | 2.31 | 0.09 | 10.0 | 1.5 | 78 | 1 |
| Italy (Appennines) | 10.7 | 0.9 | 2.29 | 0.15 | 10.3 | 1.9 | 223 | 7 |
| <i>C. R. PARVULA</i> | | | | | | | | |
| Austria & Switzerland | 9.3 | 0.6 | 2.15 | 0.12 | 16.4 | 2.6 | 316 | 10 |
| France (N. of 47°N.) | 9.6 | 0.7 | 2.18 | 0.14 | 17.1 | 2.8 | 162 | 5 |
| France (S. of 47°N.) | 9.5 | 0.6 | 2.17 | 0.14 | 17.4 | 2.4 | 158 | 5 |
| Intermediates between <i>C. R. PARVULA</i> and <i>C. R. RUGOSA</i> | | | | | | | | |
| S. France | 9.7 | 0.8 | 2.26 | 0.14 | 12.6 | 2.0 | 79 | 2 |

in various other Clausiliidae (e.g. *Alinda biplicata* (Montagu)) and was described in detail for *Macrogastra densestriata* (A. Schmidt) by Stępczak (1970). Much of the complex conchological variability of Pyrenean populations of *C. bidentata* (cf. Käufel 1929) is correlated with altitude, with lowland forms recalling those from elsewhere in southern France whereas the forms from the highest elevations resemble those from the Arctic in Scandinavia (Table 1; see also Pl. 5). It must be emphasised that this variability is clinal, with far more intermediate than extreme populations.

Populations in the extreme south-east of France (Dept. Alpes-Maritimes) are notably large and slender and in view of their distinctive ribbing, discussed below, they stand somewhat apart from other populations of *C. bidentata* (Pl. 5). They have been separated as *C. crenulata* in the past.

The spacing of ribbing on the shell in *C. bidentata* tends to be even more variable than shell height and breadth. Immature shells of *C. bidentata* in Britain grow one rib each day and the spacing of ribs presumably therefore reflects conditions during shell growth (cf. Thorson 1930, C. R. Boettger 1932, Rensch 1932, Jackiewicz 1965, Stępczak 1970). It is thus not surprising that the spacing of ribs on a single shell often varies from one whorl to another.

The density of ribs (number per mm) shows a clear pattern of regional variation, with much closer ribbing in northern and montane populations than in those of southern lowland regions (Table 1). This presumably results from slower growth of the snails in cold regions. Conversely, the wide spacing of ribs in many populations in southern France (such as *crenulata*) may reflect optimal conditions for growth.

The thickness of adult shells varies considerably. As in many other land snails, there is an obvious correlation between calcium availability and shell weight, populations living on limestone rocks generally having thick heavily calcified shells whereas those in acid woodland have thin weakly calcified shells. The extent to which apertural folds are thickened and reinforced is directly correlated with the overall extent of shell calcification. In particular, occurrence of additional small interlamellar folds tends to characterise the heavy-shelled populations of calcareous habitats.

(2) *C. rugosa* and *parvula*

Topotypical *C. rugosa* from Montpellier differ from typical French *C. bidentata* in having a somewhat smaller and more slender shell, with a club-shaped rather than fusiform outline, with somewhat coarser ribbing (Pl. 5). Nevertheless, variability within and between local populations provides considerable overlap between the species in all of these characters (Table 1). Thus in the regions of sympatry species identification based on shell characters alone is often unsafe except with the more extreme shell types. However, the two often occur together and then bimodal distribution of shell measurements usually makes it clear that two species are present.

Almost all previous authors have regarded *parvula* as a distinct species separable by its small size and smooth or very finely ribbed shell. However, populations intermediate in shell size and ribbing occur in southern France (Pl. 5, Table 1). A form with strong and very widely spaced ribbing, *andusiensis*, is known from near Anduze, Dept. Gard (Plate 5; Gittenberger & Ripken 1981). Several populations near Anduze have ribbing intermediate between that of *andusiensis* and *parvula*.

Unlike the situation with *C. bidentata*, in *C. rugosa* and its close allies there is no clear relationship between ribbing and climatic or other obvious environmental factors. Almost smooth-shelled or finely striated forms (*parvula*) occupy a wide range from Hungary and Czechoslovakia to western France. In proportion to shell size and spacing of ribs in the finely striated forms is comparable to that in northern populations of *C. bidentata*, but the shell is much smaller so that its surface appears almost smooth to the unaided eye. Each of these ribs is likely to form daily during shell growth, as in *C. bidentata*. It is uncertain whether the very coarse ribbing of *andusiensis* reflects unusually rapid growth or formation of ribs at longer than daily intervals.

The variability of ribbing that occurs between populations in *C. rugosa* and its allies is paralleled with Austrian forms of *C. dubia* Draparnaud (cf. Klemm 1960). The latter have generally been treated as conspecific with *dubia*, despite spectacular differences in general appearance of the shells. The great variation in style of ribbing in both these groups poses questions about its adaptive significance that do not appear to have been discussed in the literature. With very small land snails elaborate shell sculpture and microsculpture undoubtedly function to reduce the surface area of shell to which particles can adhere (cf. Solem 1974), but these *Clausilia* are probably too large for such effects to be important. Instead, we suggest that the ribs serve (a) to reinforce the shell against crushing by predators, and (b) to protect the aragonitic part of the shell from corrosion by acidic rainwater. [See also reference added in proof; Kemperman & Gittenberger 1988]

The role of ribbing in increasing mechanical strength of the shell is obvious, but it has not so far as we know been studied quantitatively. In acidic habitats where shells are weakly

calcified production of ribs may represent an optimal use of scarce calcium resources to achieve the required strength of shells. Those *Clausilia* that often live in acid woodland (*C. bidentata* and *C. cruciata*) may have strongly ribbed shells for this reason. However, other strongly ribbed *Clausilia* have strongly calcified shells and live on limestone substrates (*andusiensis*; some forms of *C. dubia*). It is unclear whether these are strongly ribbed because of some special need for mechanical strength, such as to counter heavy predation, or whether the physiological cost of producing and carrying heavy ribs is anyway negligible in these highly calcareous places.

Raised ribs of periostracum undoubtedly also serve to protect the aragonitic part of the shell from corrosion by acid water, such as often occurs on rocks, tree trunks and leaf-litter. In base-poor habitats a high proportion of shells of *Clausilia* shows evidence of corrosion. Corrosion is generally most intense on the middle part of the spire on the side towards which the aperture opens: that is on the part of the shell which is dragged over the substrate as the snail moves. In extreme cases corrosion there may penetrate the entire thickness of the shell and this may result in mortality. Studies by scanning-electron microscopy of the early stages of this corrosion show that it mainly begins on the crests of the ribs, where small pits in the periostracum allow solution of the underlying aragonitic part of the rib. It is only after much of the aragonite of the rib has been lost that the areas between ribs are attacked. From SEM study it appears that microbial colonisation of the damaged shell surface may play an important role in its corrosion: at around X500 magnification raised rounded growths are often seen. Further investigation is needed to ascertain whether these are bacterial, algal or fungal. The role of ribs in retarding corrosion of the shell may be another factor accounting for the presence of strong ribbing in those *Clausilia* most common in acid woodlands (*C. cruciata* and *C. bidentata*). In contrast, the need for ribs is presumably least in forms living in highly calcareous places, such as *parvula*.

SYSTEMATICS

(a) *Population Genetic Structure*

As noted above, we have never found *Clausilia bidentata* mating despite spending hundreds of hours collecting them, in most kinds of weather, in all months of the year. Likewise, we have never found mating *rugosa* or *parvula* while collecting them extensively in the summer months. This is in marked contrast to our experience with some other Clausiliidae, such as *Charpentieria itala* (Martens) and *Cochlodina laminata* (Montagu). Whether the *Clausilia* rely mainly or entirely on 'solo-breeding' (self fertilisation or parthenogenesis) or whether they mate only at night or during a short season needs further study.

Loosjes (1941) thought that *C. bidentata* is probably capable of self-fertilisation and the absence of observations of mating suggest it may occur more commonly than outbreeding. A preliminary investigation of enzyme polymorphism in a sample of thirty individuals from a population at Thatcham, Berkshire (L.R. Noble *in litt.*) showed these to be monomorphic for all of five loci studied (MPI, GOT, PGI and MDH (two loci)). However, much more extensive studies of enzyme polymorphism are needed to properly test whether or not populations of *C. bidentata* are monogenic (or only weakly polygenic).

Self-fertilisation occurs frequently in various other groups of terrestrial pulmonates (e.g. Whitney 1938, Patterson 1970, Selander & Kaufman 1973, Foltz *et al.* 1984) so that it would not be surprising if it occurs in *Clausilia*. Its occurrence could account for persistence of differences in shell for between local populations which might consist of monogenic or weakly polygenic strains.

(b) *Summary of Morphological Characters*

As discussed above, *C. rugosa* and *parvula* resemble each other in possessing a slender loop in the penial epiphallus that is lacking (rarely present but shorter) in *C. bidentata*. The difference between the ribbed shell of topotypical *C. rugosa* and the smooth shell of topotypical *parvula* is bridged by a series of populations with intermediate shells.

(c) *Evidence of sympatry*

Table 2 summarises our field records of coexistence (occurrence of living snails within 50 m

TABLE 2

Records of sympatric occurrence of *Clausilia* (*Clausilia*) species in western Europe and the Alps. The data consists only of the authors' field records. Sympatric occurrence was defined as presence of living or freshly dead specimens of the forms concerned within 50 m of each other. The table gives the total number of localities at which such records were obtained for each pair of forms.

| | <i>bidentata</i> | <i>cruciata</i> | <i>dubia</i> | <i>parvula</i> |
|-----------------|------------------|-----------------|--------------|----------------|
| <i>cruciata</i> | 0 | | | |
| <i>dubia</i> | 4 | 7 | | |
| <i>parvula</i> | 31 | 12 | 10 | |
| <i>rugosa</i> | 13 | 0 | 0 | 0 |

of each other) for *Clausilia* species (and forms). Most possible pairs from the following list of taxa have been found coexisting: *bidentata*, *cruciata*, *dubia*; this supports the conventional view that these are three distinct species (*bidentata* and *cruciata* have not been found living together by us, but there is little overlap of their geographical ranges). There are records of *parvula* coexisting with each of those three species and of *rugosa* coexisting with *bidentata* (at 13 sites; sometimes living within less than a metre of each other). However, we have never found *parvula* and *rugosa* (nor their intermediates) coexisting.

(d) *Nomenclatural Treatment*

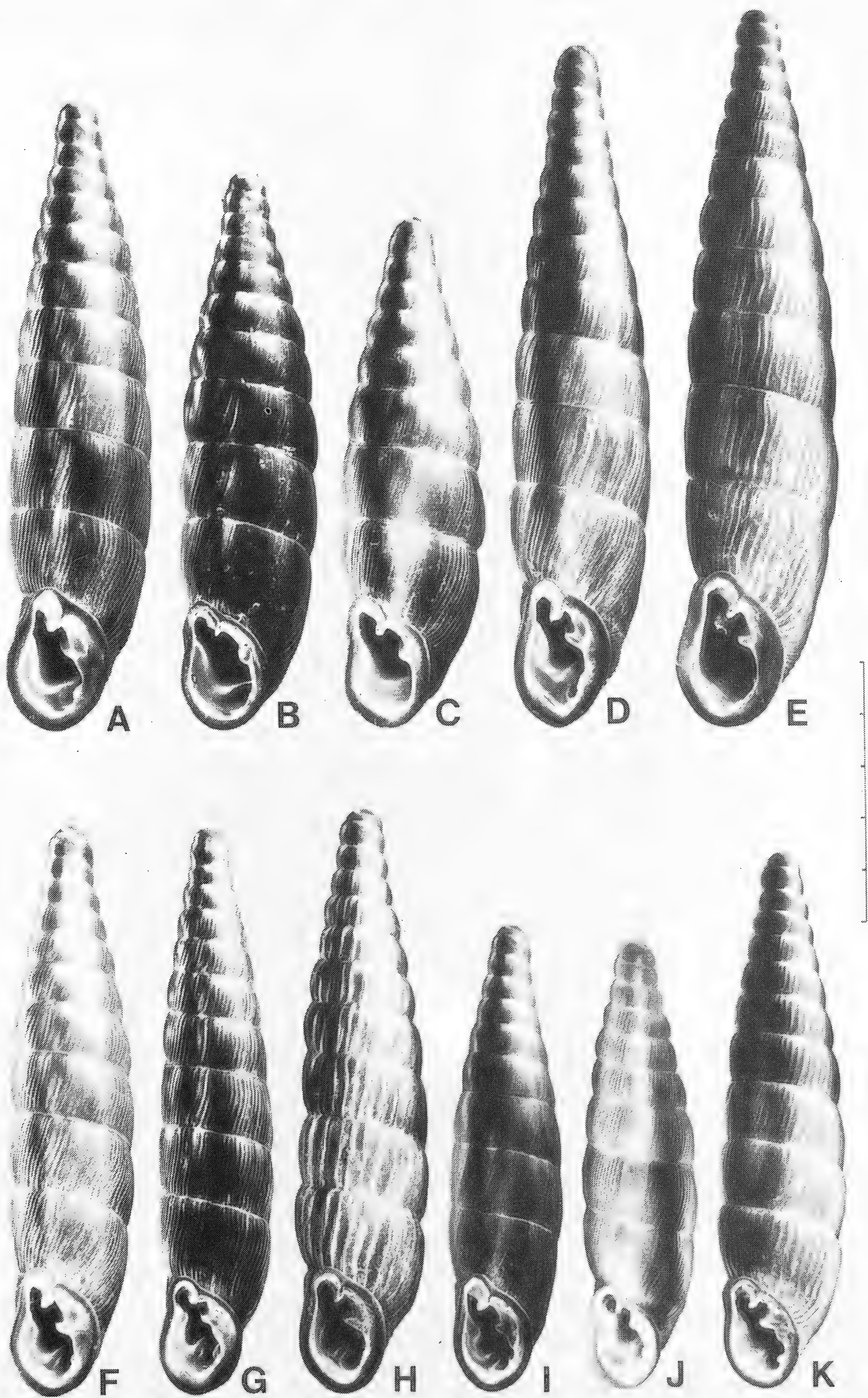
The similarity of *rugosa* and *parvula* in genital anatomy, occurrence of populations with intermediate shell form and the absence of sympatry, considered together leave little doubt that these are forms of a single biological species. *C. rugosa* Draparnaud, 1801 is the oldest name available for the species; *parvula* can conveniently be separated as *C. r. parvula* Férussac, 1807, although connected to *C. r. rugosa* by intermediates and having a partly overlapping geographical range in France. Other forms such as *pinii* (Appennines) and *andusiensis* (small area around Anduze in Dept. Gard) may also merit subspecific separation, but they are linked to *C. r. rugosa* by intermediates.

C. bidentata normally differs clearly from *C. rugosa* in genital anatomy and commonly lives sympatrically (at different sites) with *C. r. rugosa* or *C. r. parvula*, so there is no need to doubt its specific separation. Differences of shell form may make it desirable to separate the rather distinctive *crenulata* (from Dept. Alpes-Maritimes) as a subspecies of *C. bidentata*, but other southern forms approach *crenulata* and further division into subspecies (e.g. in the Pyrenees) is undesirable because intraspecific variation is largely transitional and clinal. A further reason for avoiding recognition of numerous subspecies of *C. bidentata* is that altitudinal variation closely mimics latitudinal variation so that many specimens would be hard to assign to narrowly defined subspecies.

If further studies confirm our suspicion that these *Clausilia* have many monogenic or weakly polygenic populations due to self-fertilisation, then it might be argued that numerous narrowly defined species should be recognised. However, interfertility as the usual criterion of zoological species is not readily applicable to such cases and it is more convenient to use

PLATE 5

Representative shells of *Clausilia bidentata* and *C. rugosa*. **A-E** *C. bidentata* (**A** Merioneth, Wales; coll. J. D. Dean; NMWZ 1970.40; **B** E. Porsangen, Finnmark, Norway; NMWZ 1988.9.1; **C** Hte.-Pyrenées, France, 2115 m elevation; NMWZ 1988.9.2; **D** Prov. Santander, Spain, *c.* 30 m elevation; NMWZ 1988.9.3; **E** form '*crenulata*' Alpes-Maritimes, France, *c.* 370 m elevation); NMWZ 1988.9.4; **F-H** *C. r. rugosa* (**F** Dept. Gard, France, 280 m elevation; NMWZ 1988.9.5; **G** Prov. Parma, Italy, 980 m elevation; NMWZ 1988.9.6; **H** form '*andusiensis*', 1 km N. of Anduze, Dept. Gard, France, 190 m elevation; NMWZ 1988.9.7); **I** *C. r. parvula* (Cant. Nidwalden, Switzerland, 440 m elevation; NMWZ 1988.9.8); **J** intermediate between *C. r. parvula* and form '*andusiensis*' (Dept. Gard, France, 205 m elevation; NMWZ 1988.9.9); **K** intermediate between *C. r. parvula* and *C. r. rugosa* (Dept. Hérault, France, 665 m elevation; NMWZ 1988.9.10). Scale line marked at intervals of 1.0 mm. All specimens have been lodged in Collection of National Museum of Wales, under registration numbers given.



broad if artificial species limits. The strongest argument against any temptation to recognise numerous 'microspecies' within *Clausilia* is the apparent lack of sympatry of very similar forms, which may imply that some outbreeding does occur.

(e) *Generic classification*

Nordsieck (1979) subdivided the genus *Clausilia* of other recent authors on the basis of small differences in the terminal male genitalia (cf. Forcart 1959, Nordsieck 1963, 1966, 1977) (see Fig. 1). In *Clausilia* subgenus *Clausilia* (species: *bidentata*, *cruciata*, *dubia*, *parvula*, *pumila* and *rugosa*) he retained forms having a penial retractor muscle inserting on both the penis and epiphallus near their junction. He separated the Italian *C. whateliana* from these (in subgenus *Strobiliella*), because its penial retractor muscle inserts slightly high on the epiphallus and the penis is proportionally very small. The alpine species *corynodes* and *strobili* were separated in the genus *Neostyriaca*: they have the high insertion of the penial retractor muscle found also in *whateliana*, in combination with a thickened epiphallus, proportionately larger penis and other small anatomical differences.

With genera and subgenera split this finely on small anatomical characters a case could be made for subgeneric separation of *rugosa* (including *parvula*) from the remainder of *Clausilia* (*Clausilia*). Thus, the long slender loop of penial epiphallus normally present only in *rugosa* would appear to be as important as difference as those used for subgeneric and generic separation by Nordsieck. Since a recent opinion of the I.C.Z.N. (1987) has established *rugosa* rather than *bidentata* as the type species of *Clausilia* the latter would then need to be known by an unfamiliar (sub)generic name.

We are strongly opposed to taxonomic 'splitting' of genera on this scale because the few advantages of recognising many small genera are outweighed by the frequent name changes that result. Frequent usage of the subgeneric category lengthens names unnecessarily. Pintér (1977) has objected to (sub)generic separations in Helicidae that lead to recognition of many small or monotypic units based on small differences of genital anatomy and his arguments would seem to apply with equal force here.

Such arguments based on the desire for a simple and convenient nomenclature would be negated if the small differences in terminal male genitalia can be shown to betray major genetic differences, implying wide phylogenetic separation of the species involved. However, dissection of hundreds of *C. bidentata* from scores of populations during the present study disclosed considerable intraspecific variability in size and proportions of the penis and adjoining parts of the epiphallus, as noted above. In addition, the insertions of the rather slender penial retractor muscle showed considerable individual variability in positioning, with more or less muscle inserting on penis or epiphallus (cf. Fig. 1). This may suggest that loss of any retractor muscle insertion on the penis is not indicative of a major phylogenetic gap.

We thus advocate retention of most of these species in *Clausilia* (*Clausilia*). *C. whateliana* hardly merits subgeneric separation. However, *corynodes* and *strobili* differ rather more so that their generic separation may be justified. Additional data may eventually clarify the status of these taxa, for example from biochemical studies.

(f) *Synonymies*

C. bidentata and *C. rugosa* show considerable variability in shell form, as discussed above. In the last century when a typological species concept prevailed this led to numerous forms being named as species, subspecies or varieties. Arranging many of these names into the synonymies of species now recognised is a difficult or sometimes hopeless task. Some of the nominal taxa involved had no type specimens designated; for others the types have been lost; with the minority where types survive the specimens are shells that often do not show characters allowing reliable identification with the species we recognise.

The following catalogue of species-group names should therefore be regarded only as a first step towards preparation of complete and orderly synonymies. We have no intention of further work on these as comprehensive study would require lengthy efforts to locate and study the widely dispersed type material and possible designation of neotypes to replace lost types. There would seem to be little point in making such exhaustive studies as they would not be expected to produce results of much biological interest, nor would they be likely to change the nomenclatural treatment of the taxa now recognised.

In the following section the name and original citation for each species is followed by a list of synonymous names. A third list covers those synonyms that we cannot confidently assign to either species.

C. bidentata (Ström, 1765)

Turbo (*Bidentatus*) Ström, 1765, *Trondhiemske Selskabs Skrifter*, **3**, pp. 436–437, pl. 6, fig. 17 (the application of this name was discussed by Ökland 1925 and Watson 1943).

Synonyms: *perversa* Müller, 1774, Pennant, 1777, et auctt. (not Linné, nor Férussac); *elongata* Razoumowsky, 1789 (not Studer); *bidens* Montagu, 1803 (not Linné); *nigricans* Montagu, 1803 (name not available from this date because published as synonym, see ICZN Art 10(d)); *nigricans* Maton & Rackett, 1807 [often erroneously attributed to Pulteney]; *controversus* Alten, 1812; *gracilis*, *obtusa* C. Pfeiffer, 1821; *plicata* Gaertn.: C. Pfeiffer, 1821 (not Draparnaud, 1801); *Everetti* Miller, 1822; *crenulata* Risso, 1826; ?*Marcelia* Risso, 1826; *parvula* Turton, 1826, 1831 (not Férussac, 1807); ? *obtusa* var. a. *minor* C. Pfeiffer, 1828; *plicatula* var. Hartmann: C. Pfeiffer, 1828; *crassula* Potiez & Michaud, 1838; *crasula* [sic] Potiez & Michaud: Forbes & Hanley, 1853; ? *didyma* L. Pfeiffer, 1853; *trivia* [Parr. in Sched.] L. Pfeiffer, 1853; *Everettii* Miller: Forbes & Hanley, 1853; var. *septentrionalis* A. Schmidt, 1857; *druidica* Bourguignat, 1860, 1877; var. 1 *albida*, var. 6 *dextrorsa*, var. 3 *gracilior*, var. 4 *tumidula* Jeffreys, 1862; *elegantula* [Z.] A. Schmidt, 1868; *subrugosa* Westerlund, 1871; var. D. *gracilis*, *druidica* var. B. *laevior*, *nantuacina*, *velaviana* Bourguignat, 1877; *lamalouensis* [Letourneux] Bourguignat, 1877 (*nomen nudum*); *Moniziana* Lowe: O. Boettger, 1877; *portensis* Luso da Silva: O. Boettger, 1877; *septentrionalis* [sic] A. Schm.: O. Boettger, 1877; *subuliformis* K.: O. Boettger, 1877; var. *elongata* Cles.: Esmark, 1886; *erronea* Westerlund: Esmark, 1886; *exigua* Westerlund: Esmark, 1886; var. *minor* Esmark, 1886; *hypocra*, *jurensis* Coutagne, 1886; *rupestris* [Jousseume] Locard, 1894; ? var. *strigillata* Kampmann, 1909; var. *albina* Rhodes, 1926; *oreinos* Käufel, 1929; *druiditica* Germain, 1930 (emendation of *druidica* Bourguignat, 1860); *ruchetiana* [Bourguignat MS.]: Mermod, 1930; *rugosa* of many British authors (not Draparnaud).

C. rugosa rugosa (Draparnaud, 1801)

Pupa rugosa Draparnaud, 1801, *Tabl. Moll. France*, p. 63, no. 23, pl. 4, figs. 19, 20.

Synonyms: *pinii* Westerlund, 1878; ? *Delpretiana* De Stefani, 1879; *andusiensis* Coutagne, 1886; *anduzensis* [sic] Germain, 1930.

C. rugosa parvula Férussac, 1807

Clausilia parvula [Studer] Férussac, 1807, *Essai Conciyl.*, p. 111 & Table pp. 122–123.

Synonyms: *parvula* Studer, 1789 (*nomen nudum*); *rugosa* var. c Draparnaud, 1801; *rugosa* var. *Minor* Draparnaud, 1805; *crustatus* G. L. Hartmann, 1807; var. *media* Hartmann, 1821; *parvula* var. *rugosa* Hartmann, 1821 (not *rugosa* Draparnaud, 1801); *minima* C. Pfeiffer, 1821; *paula* [Parr.] Anton, 1839; *palvula* Mermet, 1843; *minima* [Hartm. in Sched.] L. Pfeiffer, 1848; *nana* Küster, 1850 (not Parreyss in Anton, 1839); var. *agrestis* Moquin-Tandon, 1855; var. *major* A. Schmidt, 1857; *atrosuturalis*, *girathroa* Bourguignat, 1877; *Companyoi* [Bourguignat, in

sched., 1868] Bourguignat, 1877; *dilophia* [J. Mabilie] Bourguignat, 1877; *eumicra* [J. Mabilie, in sched., 1875] Bourguignat, 1877; *microlena* [Bourguignat, in sched., 1868] Bourguignat, 1877; *fallax* Jousseume, 1878; mut. *saxatilis* Suter, 1891; var. *albina* Boettger: Tomlin, 1925; *falax* [sic] Jousseume: Kennard & Woodward, 1926.

The following names are of uncertain application; each of them might refer to *bidentata* or *rugosa* (and possibly also to *dubia* in some cases): *rugosa* var. B. Draparnaud, 1805; *foliacea* Faure-Biguet in Férussac, 1821 (*nomen nudum*); ? *perversa* C. Pfeiffer, 1821; *rugosa* [Drap.] C. Pfeiffer, 1821 (not Draparnaud, 1801 ?); *rugosa* Mermet, 1843 (not Draparnaud, 1801 ?); *abietina* Dupuy, 1850; *Reboudii* Dupuy, 1850; *rugosa* var. *pyrenaica* Charpentier, 1852; *nigricans* var. *erasa*, *perversa* var. *fallax*, *minor*, *perversa* var. *modesta*, *nigricans* var. *obscura*, *perversa* var. *rupicola* Moquin-Tandon, 1855; *perversa* var. *albinos* Moquin-Tandon, 1855; *perversa* [Müller.] Moquin-Tandon, 1855; *rugosa* var. *anceps*, *minor*, *obtusaeformis* A. Schmidt, 1857; *thamnophila* Bourguignat, 1861; *Isseli* A. Villa & G. B. Villa, 1868; *Aubiniana*, *Joinvillensis*, *Maceana* Bourguignat, 1869; *aurigerana*, var. *meridionalis* Fagot, 1875; *pumicata* Paladilhe, 1875; *bigorriensis* [Bourguignat, in sched., 1860] Bourguignat, 1877; *gracilis* var. B. *apiostoma*, *Arrosta*, *belonidea*, *bizarellina*, *buxorum*, *capellarum*, *fluxumica*, *pyrenaica* var. B. *garbetica*, *gracilis* var. C. *glyca*, *aurigerana* var. B. *major*, *mamillata*, *Saint-Simonis* var. *minor*, *pyrenaica* var. C. *minor*, *obtusaeformis* var. D. *minor*, *Moitessieri*, *Penchinati*, *Penchinati* var. B. *orophila*, *pleurasthena*, *Reboudi*, *Saint-Simonis* Bourguignat, 1877; *bertronica* [Fagot in sched., 1875] Bourguignat, 1877; *perexilis* [P. Fagot mss., 1875] Bourguignat, 1877; *pumicata* var. B. *saxorum* [Bourguignat, in sched. 1865] Bourguignat, 1877; *dozolis* Duval-Jouve: Bourguignat, 1877 (*nomen nudum*); *minuta* Dupuy: Bourguignat, 1877 (*nomen nudum*); var. *Reboudi* O. Boettger, 1877; *connectens* Westerlund: O. Boettger, 1877; *Ommae* Westerlund: O. Boettger, 1877; *Andreana* P. Fagot, 1877; *pecchioli* De Stefani, 1879; *vaclusiensis* Coutagne, 1882; *lunensis* De Stefani, 1881; *pegorarii* Pollonera, 1885; *provincialis* Coutagne, 1886; *rugulosa* Ziegler: Jeffreys, 1904; *debilis* Fagot, 1905; *elongata* Caziot, 1910; *sarsi* Bourguignat [*teste* Westerlund]: Kennard & Woodward, 1926; *dubia* forme *minor* Kampmann, 1909: Favre, 1927; *gallica* Salvana: Käufel, 1929; *greixensis* Fagot: Käufel, 1929; *Havorsiana* Fagot: Käufel, 1929; *longa* Bofil: Käufel, 1929; *magdalenica* Salvana: Käufel, 1929; *penchinatiana* Rosals: Käufel, 1929; *hercynica* Uliczny: Klemm, 1960.

DISTRIBUTION AND ECOLOGY

(a) Geographical Ranges

The ranges of the five species we recognise in *Clausilia* (*Clausilia*) are shown in Figs. 3–7. The data are plotted in 50 km squares of the U.T.M. grid, on the maps prepared from the European Invertebrate Survey. In addition to distributional records obtained from our own field work we have included information from numerous publications and from specimens in most of the larger collections in the U.K. (see Acknowledgments for list). However, coverage of records from the literature is far from exhaustive and we have not attempted to obtain information from continental museum collections. Overall, coverage is best for Norway, the British Isles, France, Spain and the Alps, and conspicuously deficient for much of central and eastern Europe. Despite the gaps in coverage, the data mapped for western Europe allow comparisons of the range of each species to be made and provide a basis for comments on the relation of the ranges to climatic and other environmental factors.

C. bidentata (Fig. 3) differs from the other *Clausilia* species in having an essentially western European range. In northern and central Europe its distribution appears to be limited by winter cold, as suggested by the fact that near its northern limits in central Sweden, southern Finland, northern Norway and the Soviet Baltic it occurs only in coastal localities at low

elevations; these localities have a warmer climate than that of the region as a whole. The northernmost localities (arctic Norway) are all close to coasts warmed by the Gulf Stream. Comparison of Fig. 3 with the map of mean January temperatures in Fenoscandia given in the climatological study by Laaksonen (1977) suggests that the range limit of *C. bidentata* in that region lies within the mean January isotherm of -7°C .

At the other end of its range in Portugal and Spain *C. bidentata* may be limited by summer heat or the associated aridity. This is suggested by the fact that occurrences at the edge of its range in these countries are mainly in localities with climates that are both cooler and moister than the prevailing regional climate, either close to coasts (e.g. Prov. Barcelona in Spain; west-central Portugal) or at considerable elevations in montane areas (e.g. Prov. Logrono in Spain).

C. rugosa (Fig. 4) has a wide range in central Europe, from Czechoslovakia and Hungary to western France. Smooth-shelled forms (*C. r. parvula*) occupy much of this range, whereas ribbed forms (*C. r. rugosa*) are restricted to southern France and the Italian Appennines. *C. r. parvula* occurs at high elevations at some alpine localities (reaching 2450 m in Switzerland: Mermod 1930 m in Austria: Klemm 1974) but most of its range lies in regions that have only moderately cold winters; snow cover may provide insulation at its high alpine localities. Much of the range of *C. r. rugosa* is in warmer regions than that of *C. r. parvula* and this form has not been recorded at notably high elevations, either in the French Massif Central or the Italian Appennines.

The three remaining species, *C. cruciata* (Fig. 5), *C. pumila* (Fig. 6) and *C. dubia* (Fig. 7) all have ranges that extend much further into regions of winter cold than do the ranges of *C. bidentata* and *C. rugosa*. In Fennoscandia the edge of the range of *C. cruciata* is near Laaksonen's (*op. cit.*) mean January isotherm of -10°C . and the Finnish records of *C. dubia* are near the isotherm of -9°C . In Scandinavia *C. pumila* is restricted to the south, but records from near Moscow (as for *C. cruciata*) are from near the mean January isotherm of -10°C . In the Alps *C. dubia* and *C. cruciata* reach high elevations (Mermod 1930 and Klemm 1974 give the following maximum elevations from Switzerland and Austria respectively: *C. dubia* 2566 m and 2260 m; *C. cruciata* 2450 m and 2260 m). *C. pumila* has not been recorded at such great elevations (maximum 1800 m in Austria, Klemm *op. cit.*).

The ranges of *C. rugosa*, *C. dubia*, *C. cruciata* and *C. pumila* all differ markedly from that of *C. bidentata* in not, or scarcely, reaching the western seaboard of Europe. This difference is most conspicuous with *C. cruciata* and *C. pumila*, which consequently only overlap the range of *C. bidentata* over a small fraction of their respective ranges. *C. dubia* and *C. rugosa* show more range overlap with *C. bidentata* but still have a majority of their respective ranges apart from occurrence of that species. The absence of these species from the western seaboard of Europe may be partly related to lower summer temperatures there, but none of the species has range limits that correspond at all well to mean July isotherms. Other climatic factors, such as intolerance of mild winters seem unlikely to account for these patterns of distribution. It may therefore be easier to explain them in terms of non-climatic factors, especially as there are Pleistocene interglacial records from regions to the west of the modern range limits (see below). One possible explanation is that competition with the often abundant *C. bidentata* tends to exclude these species from the western edge of Europe, which could be true despite records of some of them occurring with populations of *C. bidentata* (cf. Table 2).

(b) Tertiary and Quaternary Fossils

Nordsieck (1972, 1974, 1976, 1981) has reviewed European Tertiary fossils of Clausiliidae. The earliest taxa he assigned to *Clausilia* (*Clausilia*) are from the Upper Miocene and there are numerous records of this subgenus from the Pliocene (Nordsieck 1981, p. 100). The

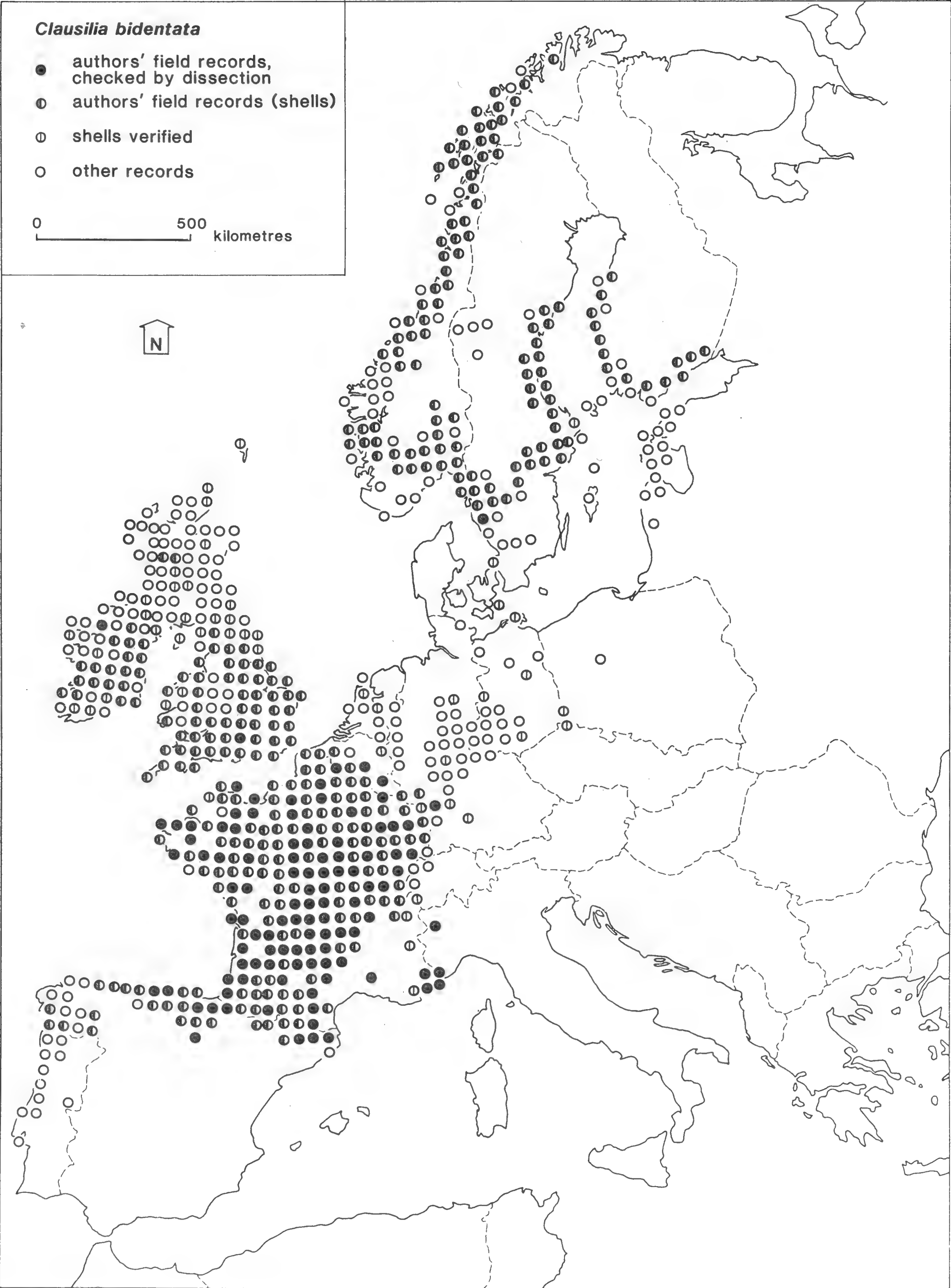


Fig. 3. Range of *Clausilia bidentata*.

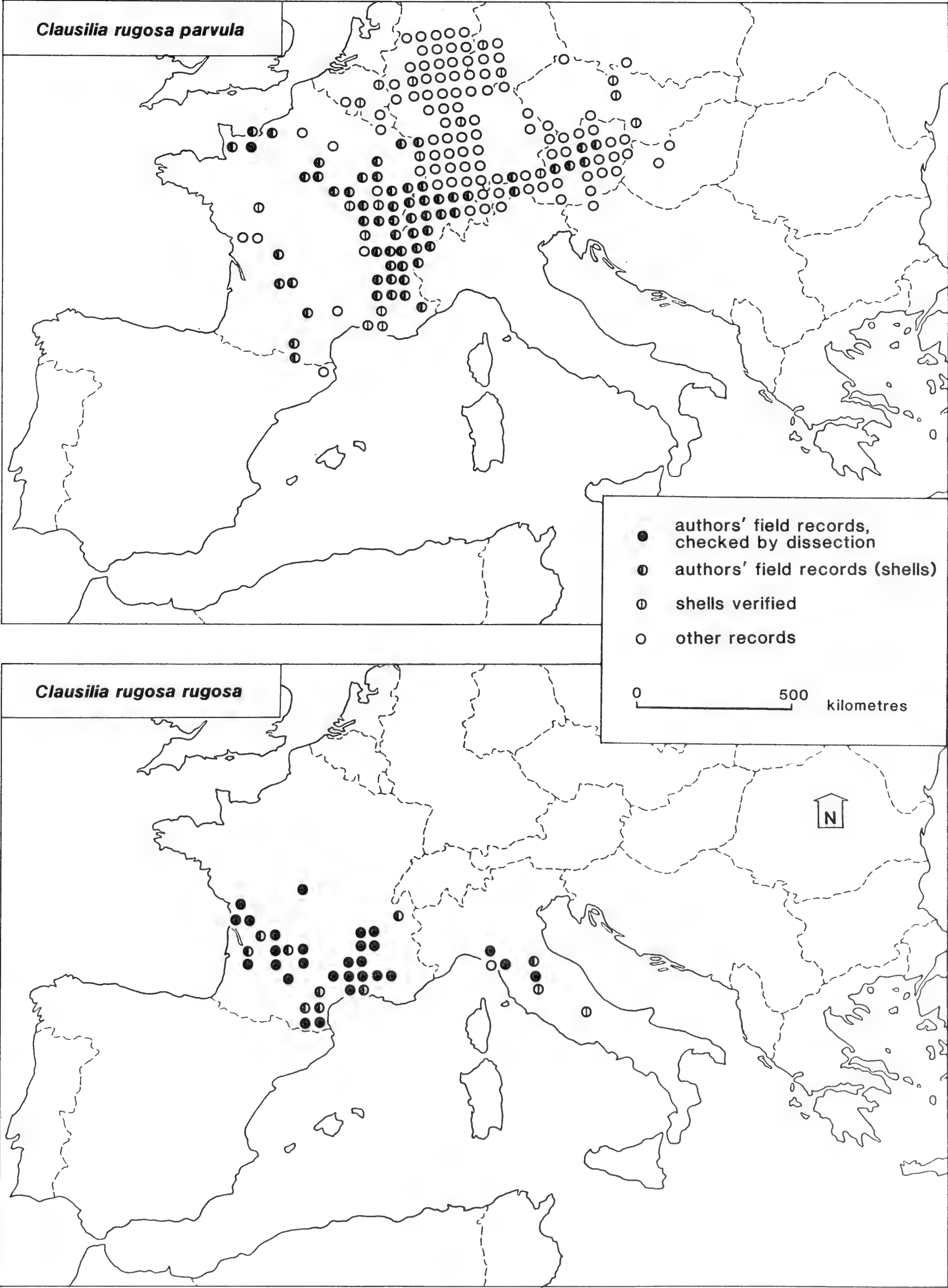


Fig. 4. Ranges of *Clausilia rugosa parvula* and *C. r. rugosa*.

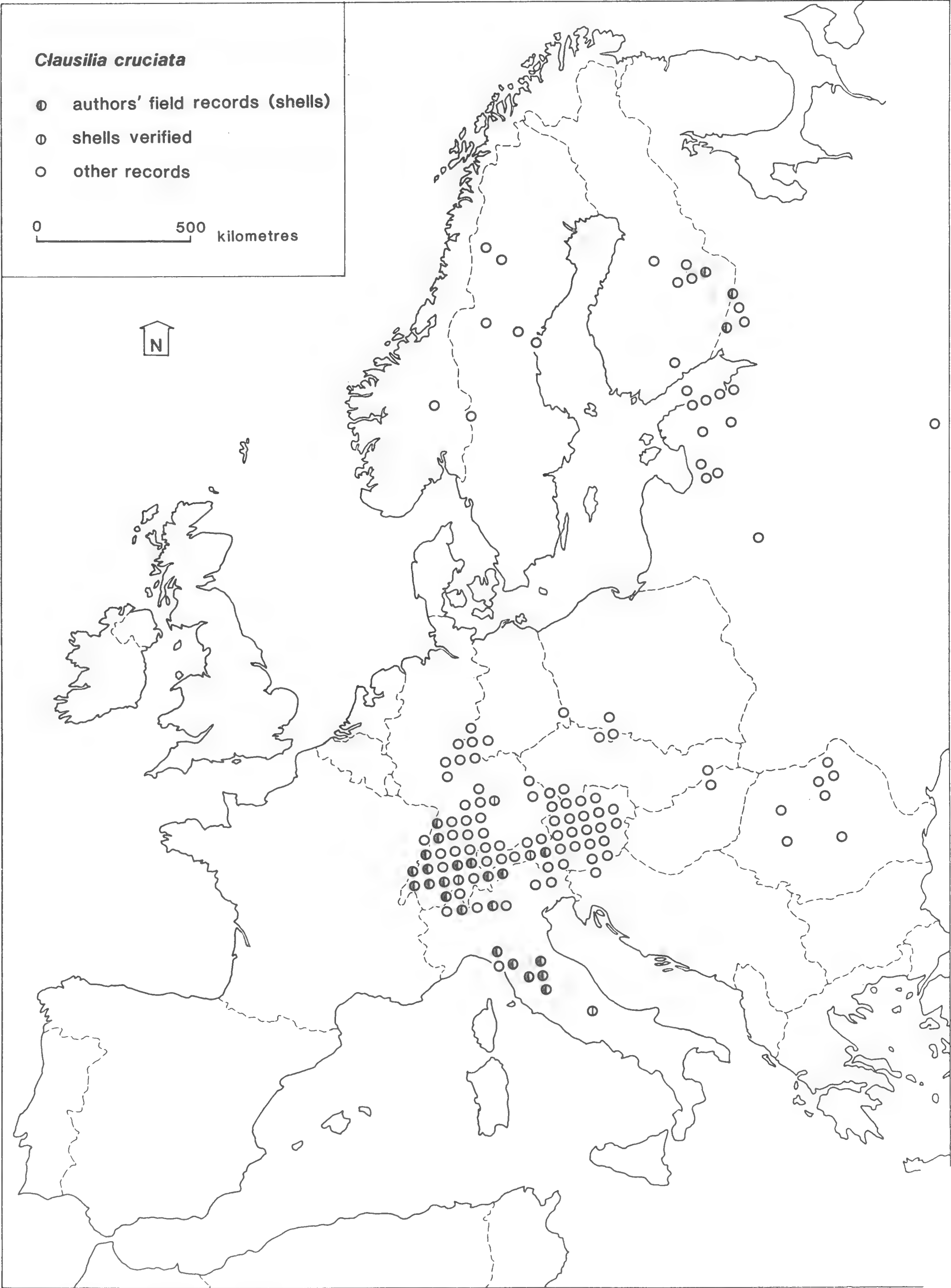


Fig. 5. Range of *Clausilia cruciata*.

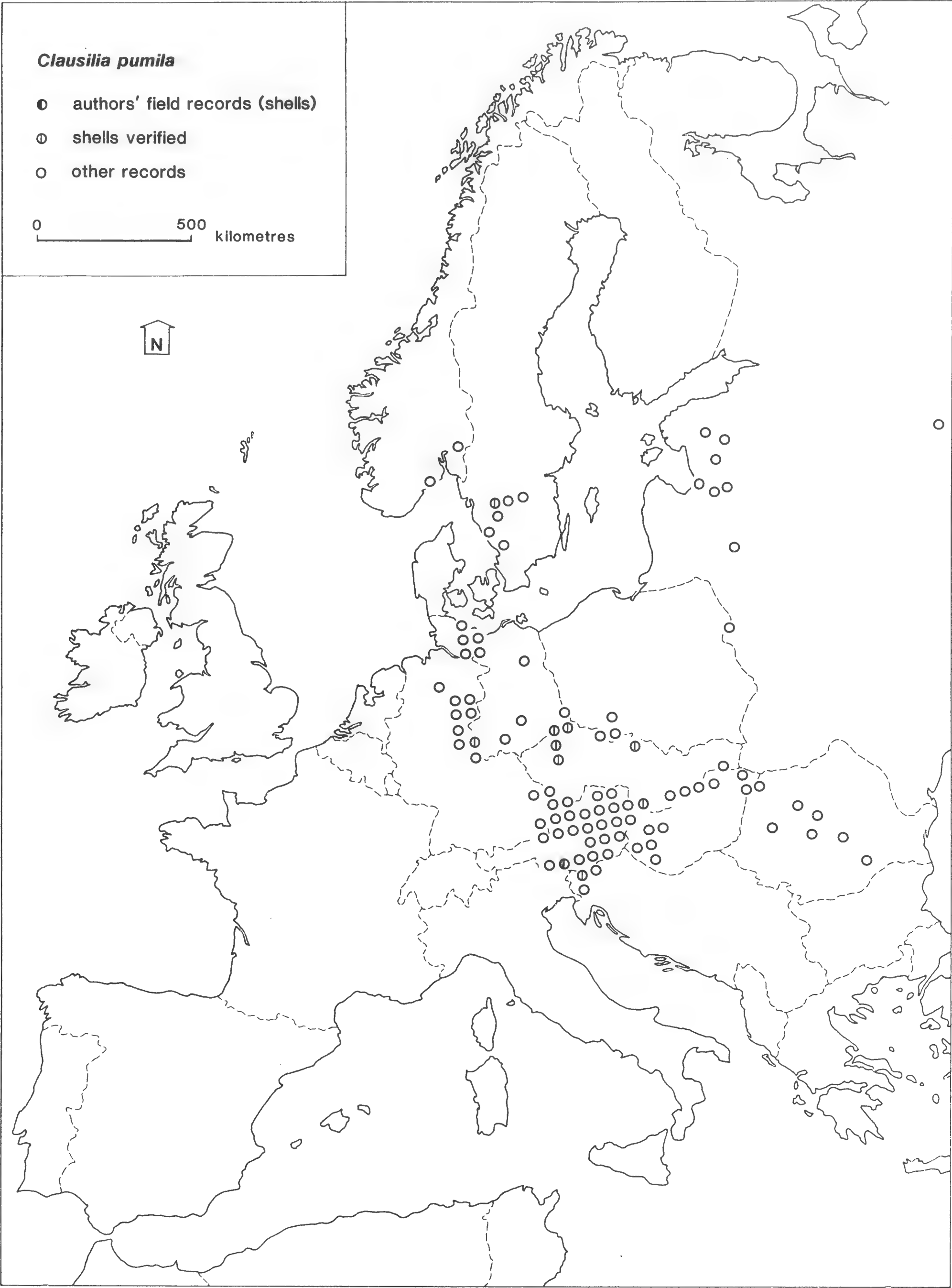


Fig. 6. Range of *Clausilia pumila*.

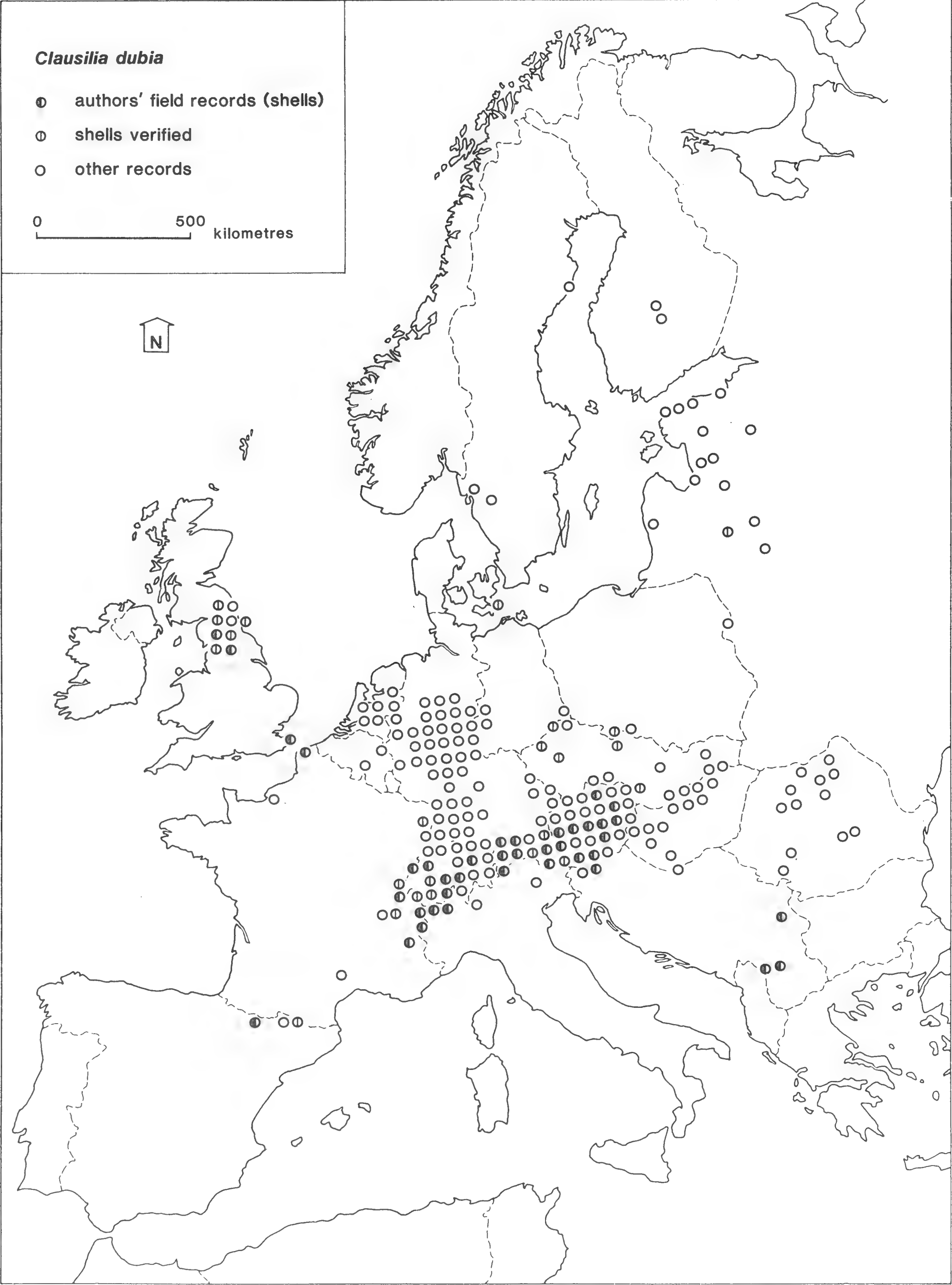


Fig. 7. Range of *Clausilia dubia*.

Upper Pliocene taxa *strauchiana*, *baudoni* and *produbia* were regarded as 'Stammformen' of *cruciata*, *bidentata* and *dubia* respectively by Nordsieck (1976, p. 78). Shells close to *C. r. rugosa* have recently been collected from the Tiglian (earliest Pleistocene) of the Netherlands (T. Meijer pers. comm.; shells identified by D.T.H.) and there are early Pleistocene reports of several *Clausilia* spp., including *C. pumila* (in Zilch & Jaekel 1962). It is thus clear that speciation of most if not all of the living *Clausilia* (*Clausilia*) preceded the Pleistocene.

The numerous Middle and Late Pleistocene fossil records provide interesting information on the distributional history of this subgenus during the climatic oscillations of the Quaternary, although uncertainty over the ages and correlation of many deposits hinders interpretation.

The British Quaternary fossils can all be attributed to interglacial stages (Evans 1972, Holyoak & Preece in preparation), the few records from cold-stage deposits probably resulting from reworking of fossils. This absence of *Clausilia* from Britain during the cold stages (cf. Holyoak 1982) points to repeated episodes of immigration during interglacials, from refugia that enjoyed milder climates during the cold stages. Several studies (e.g. Kerney, Preece & Turner 1980) have recorded the prompt appearance of *C. bidentata* in southern England early in the present (Flandrian) interglacial. Likewise Preece, Bennett & Robinson (1984) show its arrival fairly early in the Post-glacial in Scotland and Preece, Coxon & Robinson (1986) show the same for the Post-glacial in Ireland.

The rarity of well dated fossil records from southern Europe hinders location of the likely cold-stage refugia of the *Clausilia* occurring in the British Isles and elsewhere in northern Europe during the interglacial stages. However, *C. dubia*, *C. r. parvula* and *C. pumila* are recorded from loess deposits of cold-stages in Central Europe (e.g. Czechoslovakia: Ložek 1964). One may speculate that refugia for *C. bidentata* and *C. r. rugosa* lay in Italy, southern France and Spain, but only fossil records are likely to give proof of this.

It is noteworthy that interglacial fossil records of *C. pumila* and *C. r. parvula* extend beyond their present ranges in north-western Europe. *C. pumila* is recorded from southern England, far to the west of its modern range, during the Hoxnian and Ipswichian interglacials (e.g. Kerney 1959, 1971, 1976; Sparks 1964; Holyoak & Preece 1985). *C. r. parvula* is recorded from southern England in the Hoxnian, well to the north of its modern range (Kerney 1959, 1976). *C. bidentata* was also present at the same Hoxnian and Ipswichian sites, as well as at numerous other sites from which *C. pumila* and *C. r. parvula* have not been reported. It is uncertain whether these interglacial records imply different climates from that of the Flandrian (Post-glacial) or whether other factors were involved, such as for example differences in location of refugia during the preceding cold-stages.

(c) *Habitat Preferences*

Like most Clausiliidae, all species of *Clausilia* (*Clausilia*) most often occur in habitats that have steeply inclined surfaces on which they climb. Populations of all six species can be found climbing on trees as well as on rocks (including walls), and individuals in some habitats such as rocky woodland move freely from one type of substrate to another. Our own field records suggest nevertheless that some of the species prefer tree substrates and others prefer rocks (Table 3).

C. cruciata has the highest proportion of records from trees (73%), although it lives in abundance on rocks at some sites (e.g. in Italian Appennines). *C. bidentata* also occurs most frequently on trees (54%). The latter species may also occur on the ground away from trees or shrubs (5%), often where tall herbs provide surfaces on which it can climb, as for example in fens or nettle beds (*Urtica dioica*). None of the other species was represented by more than a few records from such places.

TABLE 3

Occurrence of species of *Clausilia* (*Clausilia*) in different habitat types.

Based on authors' records only, from western European and alpine countries. Figures give the number of localities for each species in each habitat type, followed (in parentheses) by percentage of all records for that species.

| | TREES | GROUND | ROCKS | WALLS | TOTALS |
|----------------------|--------------|------------|--------------|--------------|--------|
| <i>C. bidentata</i> | 405 (54%) | 38 (5%) | 124 (17%) | 181 (24%) | 748 |
| <i>C. cruciata</i> | 29 (73%) | — | 10 (25%) | 1 (3%) | 40 |
| <i>C. dubia</i> | 22 (36%) | — | 27 (44%) | 12 (20%) | 61 |
| <i>C. r. parvula</i> | 34 (35%) | 1 (1%) | 39 (40%) | 23 (24%) | 97 |
| <i>C. r. rugosa</i> | 5 (9%) | 1 (2%) | 27 (47%) | 24 (42%) | 57 |

Overall, the records of *C. dubia* are rather evenly spread between tree and rock habitats, although in some regions it is mainly rupestral (e.g. northern England) and in others it occurs mainly on trees (e.g. Netherlands). In the literature *C. r. parvula* is usually regarded as a rupestral form, but 34 (35%) of our 97 records are from trees. However, the majority of these were from smooth barked trees such as beech *Fagus sylvatica* L. and hornbeam *Carpinus betulus* L. growing in rocky limestone habitats, although there were some from other trees in places where no rocks were exposed.

C. r. rugosa had fewest records from trees (5 out of 57; 9%) and most from rocks or walls (89%). Indeed, three of these five records from trees were from rocky slopes or steep banks, a fourth was of a single shell from the trunk of an elder *Sambucus nigra* L. in scrub; the fifth (of 41 individuals) was from trunks of trees of elm *Ulmus*, maple *Acer* and ash *Fraxinus excelsior* L. on a hedgebank. *C. bidentata* records from southern France included many from trees as well as rocks, so there is little doubt that *C. r. rugosa* tends to prefer rocks or walls to trees, whereas other forms (including *C. r. parvula*) show less strong preferences.

All *Clausilia* prefer calcareous habitats. Their frequency of occurrence in base-poor places varies between species, being highest in *C. cruciata* and *C. bidentata* (which often live in rather acid woodland), and lowest in *C. r. parvula* and *C. r. rugosa* (which are usually restricted to base-rich sites).

(d) *Distributional history*

Several features of the biology of *C. bidentata* are likely to account for its success in colonising northern Europe repeatedly in successive interglacials. These include its wide ecological tolerance, enabling it to live in relatively base-poor sites and in woodland habitats where there are no rocks. This may account for it being more widespread in western Europe than *C. rugosa* subsp., not only at the present day, but apparently also during at least two interglacials of the Middle and Late Pleistocene. If self-fertilisation occurs in this species, as suspected, then this may be of great advantage to it in colonising unoccupied regions: only a single individual would need to be displaced in order to establish a population.

There can be little doubt that other *Clausilia* species which occur in northern Europe (*C. cruciata*, *C. dubia*, *C. pumila*) have also been repeated immigrants to this region in successive interglacials. These species also occur in woodland habitats, sometimes in rather base-poor places. It is difficult to account for their failure (*C. cruciata*, *C. pumila*) or very limited success (*C. dubia*) in colonising the western seaboard of Europe in the Post-glacial, especially as *C. pumila* occurred much further west in at least two interglacials. Difficulties of dispersal seem unlikely to be the whole explanation as these species have succeeded in colonising

Scandinavia. Perhaps the most likely explanation is that they are now at some competitive disadvantage to *C. bidentata*, which is an abundant species over much of the western seaboard of Europe. This explanation would be supported by the largely allopatric ranges of *C. bidentata* and the other species and their rather infrequent coexistence within regions of range overlap (cf. Table 2), but it needs experimental verification. Other possible explanations might involve some hypothetical predator, parasite or disease which *C. bidentata* is better able to resist than are the other species.

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REVIEW

Tropical Landshells of the World. Brian Parkinson, with Jens Hemmen and Klaus Groh. Verlag Christa Hemmen. Wiesbaden, West Germany, 1987. 279 pp. 77 pls. £70.00

This sumptuous volume could have been much more than just an introduction to tropical land shells, which is all that it amounts to. The introduction to terrestrial molluscs covers their origin, classification and biology. It is followed by useful regional accounts, helpfully divided into regions. These review the major mollusc groups present and list references to that region. These reference lists are necessarily very incomplete. The authors are to be congratulated on the excellent photographs of living animals which accompany the regional accounts. Two maps showing the natural forms of vegetation in the Tropics and the zoogeographical zones are provided.

The 77 coloured plates depicting shells are excellent but unfortunately the best use has not been made of them. Plates 1–7 are devoted to the genus *Liguus*, including endless varieties of *L. fasciatus*. In view of the number of genera entirely omitted from this work, surely one plate would have sufficed. The same applies to plates 9 and 10 which figure numerous varieties of *Polymita picta* created by Torre, 1950 which the author must have thought up when he had nothing better to do! The family Camaenidae is again over represented: pls. 56–57 and elsewhere. The choice of genera to illustrate is not well balanced since some 60 are entirely unrepresented. Very beautiful small shells such as *Opisthostoma* could have been included, enlargements of these would have been very welcome. Amongst the genera with which the reviewer is familiar there are numerous incorrect identifications. On pl. 15 the genus *Gonyostomus* in the family Strophocheilidae is represented by an unnamed shell, probably a species of *Drymaeus* but certainly not a member of this genus. Yet on pl. 16, fig. 17 *G. gonyostomus* is correctly identified. Pl. 15, figs. 10–11 represent *Cyclodontina labrosa* (Menke) not *C. inflata* (Wagner). Pl. 16, fig. 1 is a colour form of *Porphyrobaphe iostoma* (Sow.) (see also pl. 17, figs. 4–5) The locality 'Chile' given for *P. iostoma* is certainly erroneous. It is known only from Northwestern Peru and Ecuador. Pl. 17, fig. 2 is not *Sultana atramentaria* (Pfr.) but *S. approximatus* (Fulton). Pl. 19, figs. 1–2 are probably both the same species. It is not possible to identify *Strophocheilus valenciennsii* (Pfr.) without an adequate description! Fig. 4 is *S. terrestris terrestris* (Spix) not *S. granulosus* (Rang) nor is fig. 8 *S. g. abbreviatus* Bequaert but a form of *S. oblongus* (Müll.) *S. granulosus* is a species the senior author has apparently never seen. Plates 20–26 cover the Achatinidae. Pl. 20, fig. 1 is *Pseudachatina gabonensis* (Shuttleworth) not *S. sodeni* (Kobelt); pl. 21, fig. 4 gives a totally false impression of *Perideropsis fallsensis* Dautz. & Putz. a strikingly coloured and beautiful species. Pl. 22, figs. 7–8 *Limicolaria martensiana* (*martensi* is a misspelling); figs. 7–8 not *L. m. karagwensis* (*karagweensis* is a misspelling) but a unicolourous form of *L. martensiana* (Smith, 1880) figs. 9–10 *L. pallidistriga* Mts., 1895 is a synonym of *L. martensiana* (Smith, 1880); fig. 14 is *L. cailliaudi* Pfr. 1850 (= *festiva* Mts., 1869); fig. 15 *L. dimidiata* Mts., 1890 (not 1880) is a synonym of *L. martensiana* (Smith, 1880) a species not recorded from the Sudan. The shell illustrated is *L. turris* (Pfr., 1861); figs. 16–17 represent *L. martensiana fuscescens* Mts., 1897 synonym *L. smithi* Preston, 1906 (not *L. smithi* Pilsbry, 1904). Pl. 24, figs. 1 and 8 *Achatina* (*Lissachatina*) *immaculata* Lamarck, 1822 (*panthera* Férussac, 1821 is a *nomen nudum*); pl. 26, fig. 2 is *Archachatina* (*Archachatina*) *bicarinata* (Brug., 1792) not *Achatina*! This species is the type by subsequent designation of Pilsbry, 1904 of the genus *Archachatina* Albers, 1850; fig. 3 is *Archachatina* (*Calachatina*) *marginata* (Swainson, 1821) again not *Achatina*!

Pl. 30, fig. 2 represents *Clavator eximus* (Shuttleworth, 1852) not *C. clavata* (Petit, 1844); pl. 35, fig. 8 is in *Phoenicorbis* not *Camaena*; fig. 9 also, careless editing! Pl. 36, figs. 15–16 see also pl. 55, figs. 12–15. These are stated to be different species! How do you tell them apart without a description? Pl. 48, figs. 8–9. It is not surprising that these two shells are referred to only as *Cochlostyla* sp. since both are obvious fakes for which the Philippine islanders are famous or perhaps infamous. Pl. 55, figs. 12–15 compare with pl. 36, figs. 15–16. These are all the same species whatever this may be. Pl. 68, figs. 4–5 *Placostylus fibratus* (Martyn, 1784) is an unavailable name since the ICZN ruled in 1957 that Martyn's "Universal Conchologist" was officially rejected for nomenclatorial purposes. *P. elongatus* (Lightfoot, 1786) is the next available. Pl. 71, fig. 5 is *P. sanchristovalensis* (Cox, 1870) not *P. hargravesi* (Cox, 1871) Fig. 6 is *P. cleryi* (Petit, 1850) (decorticated shell) not *P. stuchburyi* (Pfr., 1860) (not 1856).

In view of the small amount of information given in the explanations to the plates and the considerable waste of space on these pages, there seems little justification for the complete failure to provide descriptions of the species illustrated. I wonder how the authors expect the users of this work to identify specimens when often only one figure is provided. Should this be a back view then there is no indication of the shape of the aperture and you are left to guess what type of sculpture, protoconch etc. the shell in question may have.

This beautifully illustrated work could have been of invaluable assistance to all those interested in tropical land shells. The lack of descriptions and the fact that so many genera have been omitted, when many more could have been included had the plates available been better used greatly reduces its value as a working tool. A wonderful opportunity and a great deal of hard work seems to have been wasted in consequence. The high price asked for this book in the U.K. £70.00 can only be justified by the introductory chapters and the excellent plates.

T. PAIN

NASSARIUS (HIMA) ADAMI A NEW SPECIES OF NASSARIIDAE (MOLLUSCA: GASTROPODA) FROM ANGOLAN COASTAL WATERS

ALEX R. ARTHUR¹ AND FRANCISCO FERNANDES²

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Abstract: *Nassarius (Hima) adami* n. sp. is described from material collected on the coast of Angola. The new species is compared to *N. (Hima) incrassatus* (Strom, 1768). It does not closely resemble any other known species of Nassariidae but is clearly related to species currently placed in the subgenus *Hima* (Leach in Gray, 1852).

INTRODUCTION

The family Nassariidae is a fairly large group of Neogastropods well distributed in most of the world seas. The West African representatives of this family have been studied recently by W. Adam and J. Knudsen (1984) and W. O. Cernohorsky (1984). Thanks to these and a few other authors, the worldwide Nassariidae are fairly well known. Over 20 specimens of the new species described here were found by dredging in sand at 7–10 metres depth at the type locality in March, 1985 but has not been found by either author in any other locality or amongst any of the collections or literature consulted.

This species is named after Prof. Dr. William Adam of the Institut Royal des Sciences Naturelles de Belgique, Brussels, who has done much to improve our knowledge of the Nassariidae in the West African region.

***Nassarius (Hima) adami* n. sp.** (Pl. 6, figs 1–3; Pl. 7, figs. 1–3)

Shell small, solid, up to about 10 mm in height with 4 to 5 strongly convex teleoconch whorls. Sculpture of axial ridges and spiral threads, varying greatly in prominence and number; axial folds around the last whorl range in number from 8 to 14; spiral threads range from 8 to 10. Protoconch of 2 to 3 smooth, inflated, broad and proportionately large whorls. Outer lip strongly variced, making the last whorl relatively broad. Aperture ovoidal; relatively small, as the outer lip is heavily thickened on its inner edge. Siphonal canal short and fairly constricted; interior of outer lip ornamented with fine, regular ridges, which extend well into the aperture. Inner lip lightly calloused and ornamented with numerous fine ridges over the whole height of the columella. Siphonal notch prominent; anal canal relatively shallow. Exterior pale cream to pale buff. Axial ribs of most specimens paler in colour than the base, and terminal varix white on a few specimens. Some specimens have dark brown spiral bands above sutures and on last whorl, beginning above aperture. Aperture polished, white, with brown spots on inner margin of outer lip and a prominent brown blotch to right of siphonal canal on some specimens. Spire whorls a little darker than rest of shell on most specimens.

In general shape and size, the new species most resembles *Nassarius (Hima) incrassatus* (Strom, 1768), type species by SD (Marwick, 1931) of the subgenus *Hima* Leach in Gray,

¹ 32, Heathfield North, Twickenham, Middx. England.

² C.P. n. 12427 Luanda, Angola.

1852, a well known N.E. Atlantic and Mediterranean species. As with many Nassariidae, the new species would seem to be quite variable in shape, sculpture and colour, however, a most distinctive feature of the new species by which it can be easily separated from both *N. incrassatus* and all other E. Atlantic species, is the aperture which is ornamented with numerous fine, regular ridges that extend well into the aperture on the interior of the outer lip and cover the whole length of the columella.

Type locality

This species was found by dredging at 7 to 10 metres depth, in sand at Corimba Bay, Luanda, Angola.

Type material

Holotype – 9.7×5.8 mm. Deposited in the British Museum (Natural History), London, U.K. Registered no. 1986089 (Pl. 6, fig. 1; Pl. 7, fig. 3)

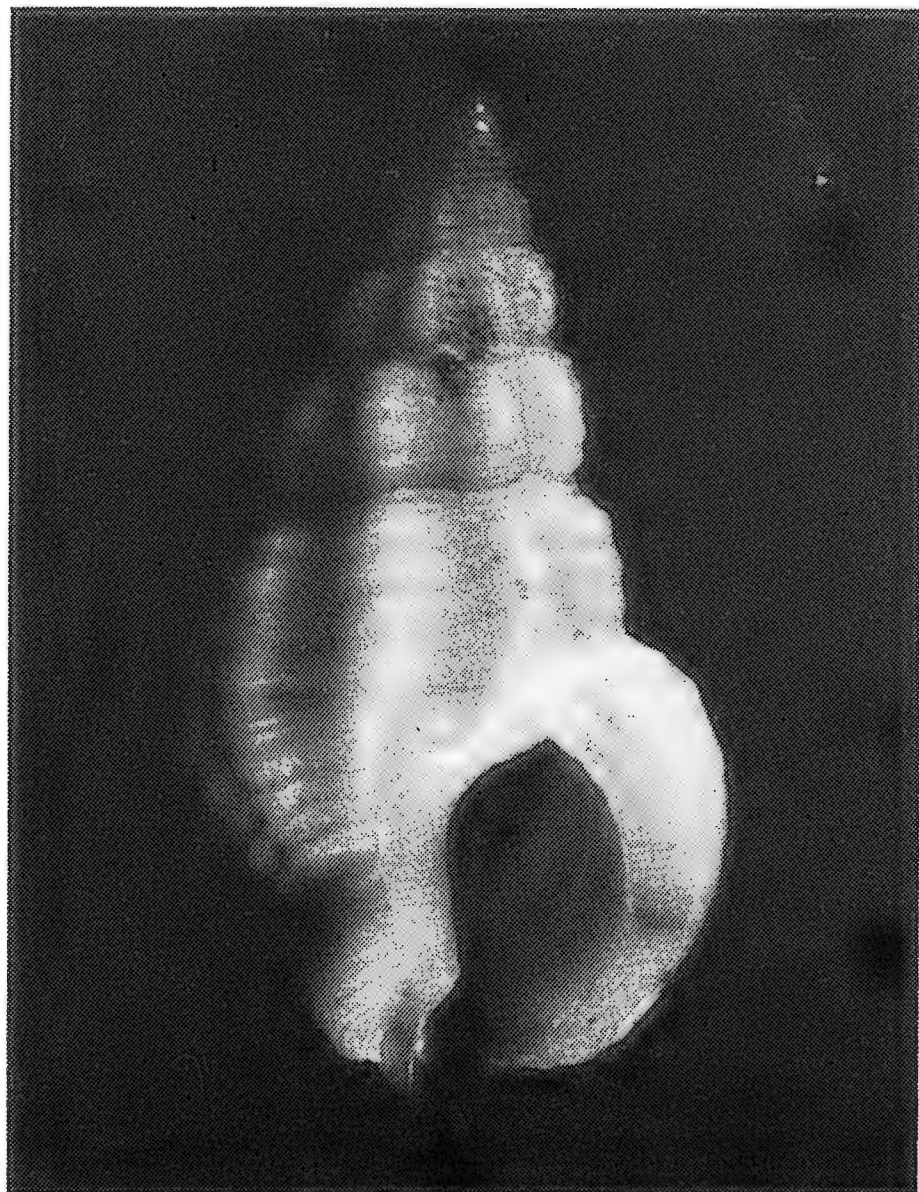
Paratype 1 – 7.4×4.4 mm. A. R. Arthur collection, London, U.K. (Pl. 6, fig. 2; Pl. 7, fig. 1)

Paratype 2 – 8.4×5.0 mm. F. Fernandes collection, Luanda, Angola. (Pl. 6, fig. 3; Pl. 7, fig. 2).

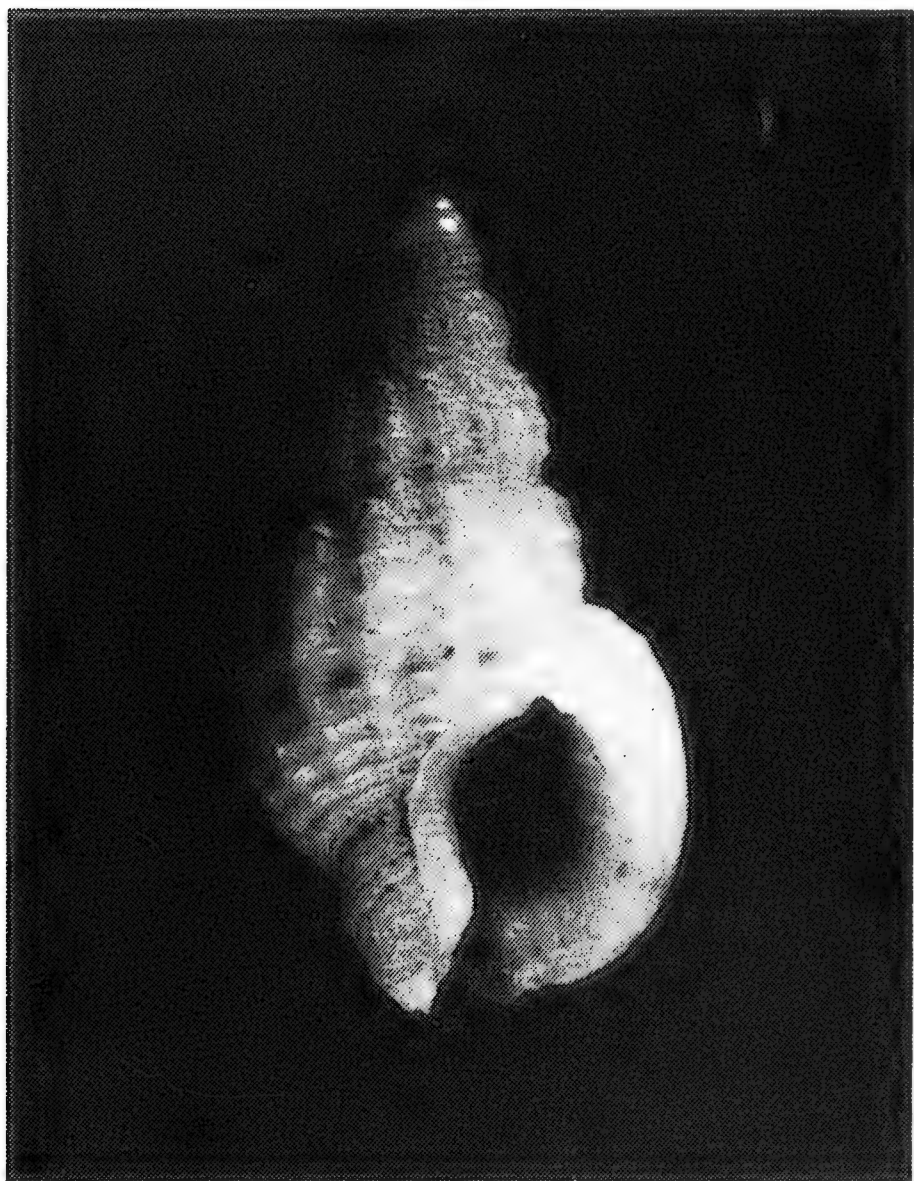
Numerous unmeasured and unfigured paratypes in the authors' collections.

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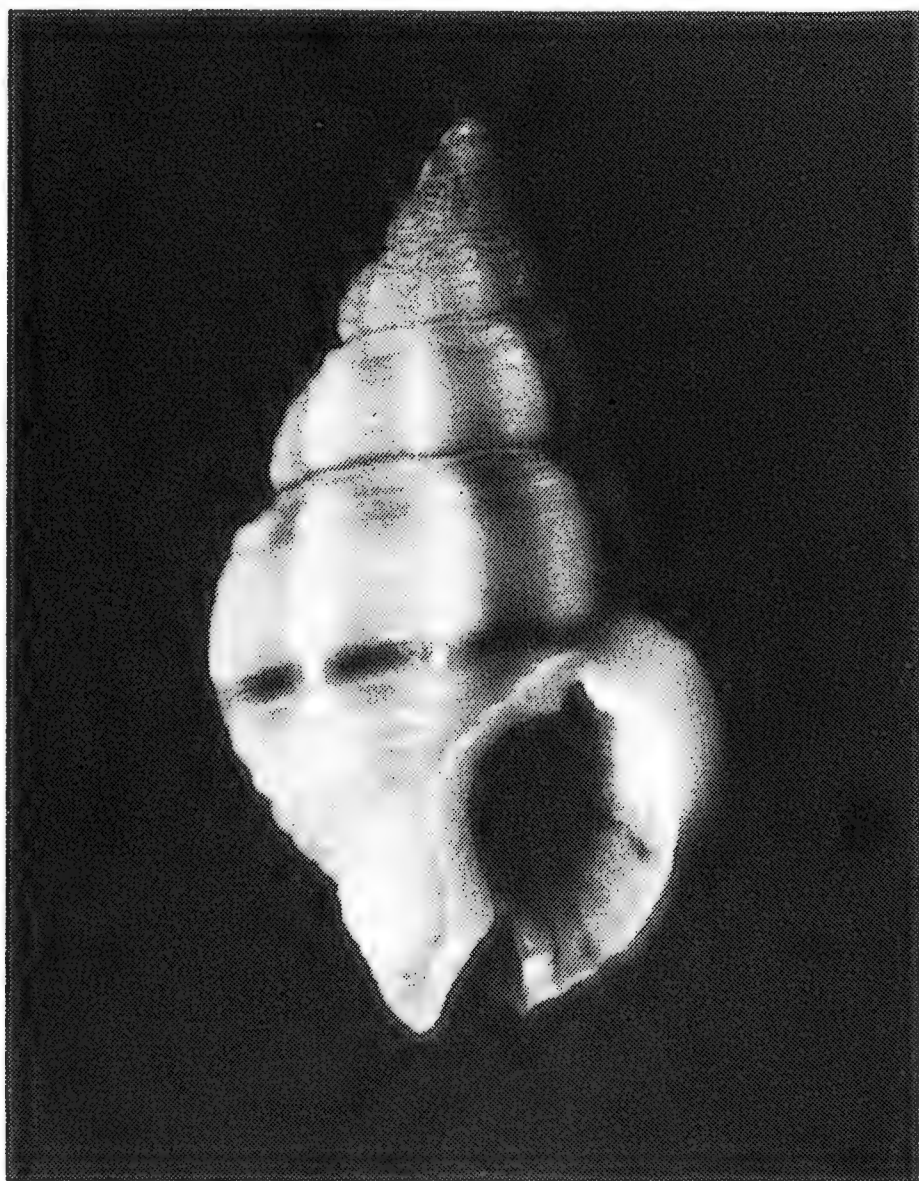
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1



2



3

PLATE 6

Nassarius (Hima) adami ventral views

fig. 1, Holotype; 9.7×5.8 mm. fig. 2, Paratype 1; 7.4×4.4 mm. fig. 3, Paratype 2; 8.4×5.0 mm.

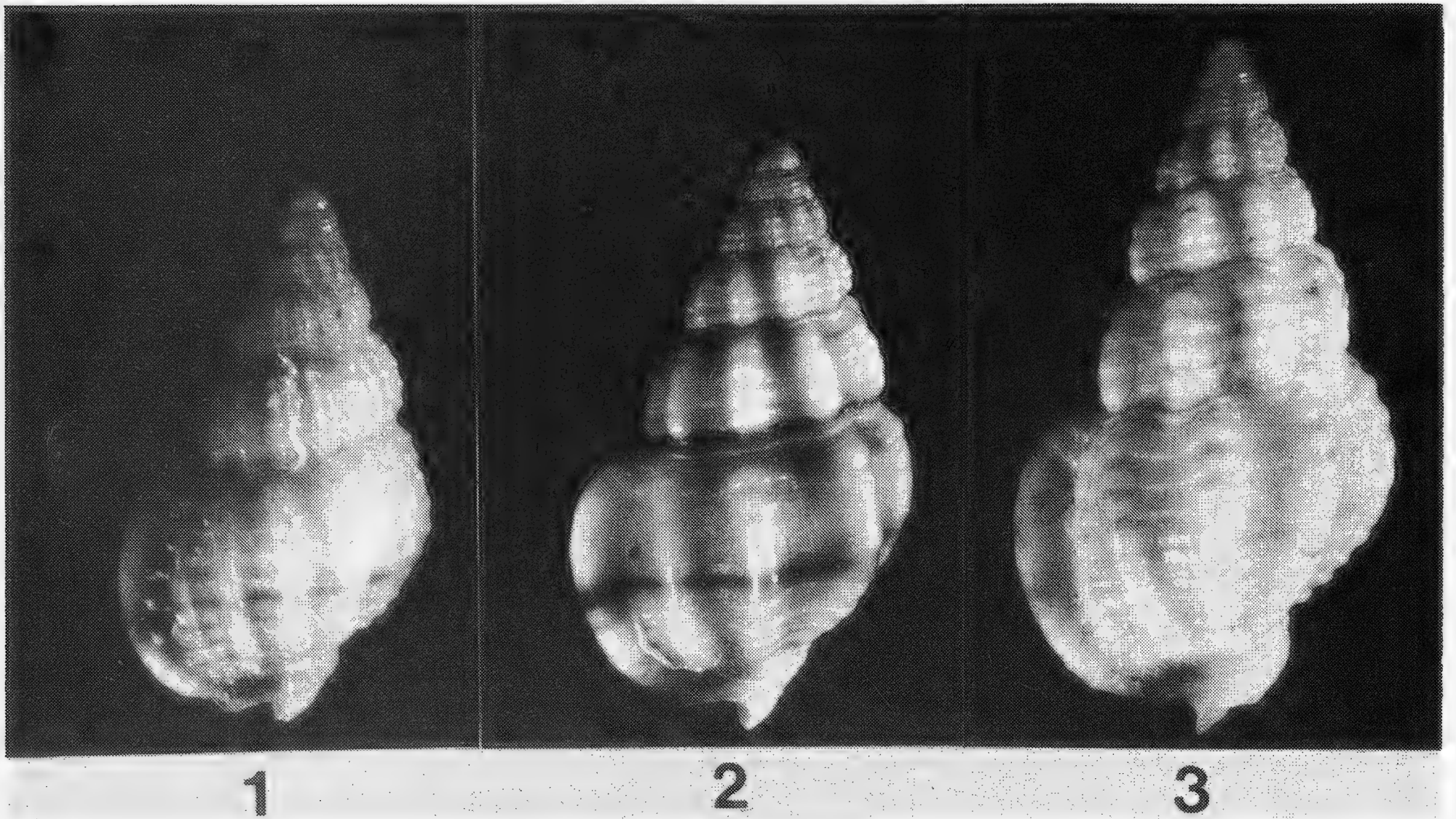


PLATE 7

Nassarius (Hima) adami dorsal views
fig. 1, Paratype 1. fig. 2, Paratype 2. fig. 3, Holotype

COMMENTS ON “A RECLASSIFICATION OF THE RECENT GENERA OF THE SUBCLASS PROTOBRANCHIA (MOLLUSCA: BIVALVIA)” BY J. A. ALLEN AND F. J. HANNAH (1986)

PHILLIP A. MAXWELL¹

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Abstract: A commentary is provided on nomenclatural and taxonomic points arising from Allen and Hannah's classification of protobranch bivalves (*J. Conch. Lond.*, 32 (1986) pp. 225–249) and an attempt is made to reconcile their classification with one proposed by Scarlato and Starobogatov (*Trudy Zoologicheskogo Instituta, Akad. Nauk SSSR*, 80 (1979) pp. 5–38). A number of changes are made to the names and authorship of certain family – group taxa, and several genus-group taxa not considered by Allen and Hannah are discussed. The new sub-family Nuculominae is proposed for those nukulids lacking radial structural elements. *Lamellileda* Cotton, 1930 is synonymised with *Poroleda* Hutton, 1893.

INTRODUCTION

Allen and Hannah (1986) have recently proposed a new supraspecific classification of extant protobranch bivalves that differs markedly from the ‘standard’ classification adopted by the authors of the relevant sections in the ‘Treatise on Invertebrate Paleontology’ (Moore 1969, pp. N227–243, 269) and by Vokes (1980, pp. 1–8, 21–22). In particular the latter authors do not recognise a subclass ‘Protobranchia’, but include the Nuculacea and Nuculanacea in the Palaeotaxodonta, the Solemyidae in the Cryptodonta, and the Nucinellidae (or Manzanellidae) in the Pteriomorphia. This arrangement reflects Newell's conclusion (1965, pp. 10–11) that the nukuloids and solemyids are not closely related and that the presence in both groups of comb-like gills merely means that they are at the same evolutionary grade, i.e. the protobranches are a ‘horizontal’, paraphyletic rather than a ‘vertical’, monophyletic group according to this interpretation. However, the recent discovery of a Silurian bivalve that seems to be intermediate between nukuloids and solemyoids (Liljedahl 1984), and the demonstration by Allen and Sanders (1969) that *Nucinella* shares several important anatomical characters with solemyids, give some support to the idea that the protobranches constitute a monophyletic group which is amply separated from other bivalves and therefore worthy of high-level taxonomic rank in the Bivalvia. (It should be noted however, that this is essentially an ‘evolutionary systematics’ view of bivalve classification – a cladist would probably object that nukuloids, solemyids and nucinellids are united on the basis of presumed primitive characters and therefore constitute a paraphyletic group.) The other major difference between the two classifications is that the older one includes only 5 extant families, whereas Allen and Hannah recognise no less than 14 extant families and subfamilies of protobranches.

Another recent classification of the Bivalvia, not referred to by Allen and Hannah, is by the Russian workers Scarlato and Starobogatov (1979) (English translation 1985). This differs radically from earlier classifications mainly because the authors have chosen to

¹ New Zealand Geological Survey, P.O. Box 30–368, Lower Hutt, New Zealand.

elevate many previously proposed families to superfamily rank, and to propose numerous new families, often with little or no justification. They do not recognise subclasses in the Bivalvia, but rank Protobranchia as a 'superorder', subdivided into two orders, Nuculida (with seven superfamilies) and Solemyida (with five superfamilies). Of the 23 families in their Protobranchia, 16 have living representatives. In some respects their classification is much closer to that of Allen and Hannah than to the Vokes – 'Treatise' classification.

Although Allen and Hannah's paper represents a major contribution to the study of these fascinating but difficult bivalves, there are a considerable number of points arising from it, some of them resulting from the authors' failure to consider several important papers dealing wholly or partly with protobranchs. My comments relate to a) the question of the earliest available name for certain taxa (particularly those of family-group taxa); b) the omission of several relevant genus-group taxa; and c) the limits and content of some genus-group taxa. The points made in the third category of course are relatively subjective and to a large degree they reflect my own taxonomic approach, which is that of paleontologist trying to collate the extensive fossil material with the (usually) better-known extant species. One of the drawbacks of Allen and Hannah's classification is that it deals only with extant taxa, and although I appreciate the difficulties inherent in making sense of the numerous fossil forms, this restriction means that a potentially valuable perspective on our understanding of the subclass has been disregarded. Allen and Hannah complain that many of the difficulties of interpreting or defining protobranch taxa arise from 'the lack of adequate description and poor knowledge of the anatomy'. Paleontologists, who of course normally have only the shells for study (but see Cox 1960), can only agree with the comment on inadequate description, and I would add that poor illustrations also greatly contribute to the problem. It would help not only paleontologists but also neontologists if descriptions of the smaller protobranchs were augmented with good-quality scanning electron photomicrographs – drawings are rarely good enough to show the fine details of sculpture (including microsculpture), hinge, ligament and muscle scars necessary for accurate characterisation.

COMMENTS ON INDIVIDUAL TAXA

1 *Solemyoida*

Allen and Hannah recognise only two families, Solemyidae Gray, 1840 and Nucinellidae Vokes, 1956, in this order. They eschew the use of superfamilies in the Solemyoida, as they claim that each would include only a single family and therefore take the same definition as the included family. However, by recognising the family Nucinellidae, they are implying that this can be separated from the prior Manzanellidae Chronic, 1952 which is based on the Permian genus *Manzanella* Girty, 1909. Such a separation may be warranted, although Keen and Newell (in Moore 1969, p. N269) consider these families synonymous. In any event, the differences between solemyids and nucinellids are so great as to require superfamilial segregation at the very least, a distinction that should be reflected in the classification.

Scarlato and Starobogatov (1985, p. 18) subdivide the Solemyoida into two suborders, Nucinellina (with three superfamilies Afghanodesmatacea, Manzanellacea and Huxleyiacea) and Solemyina (with Acharacacea and Solemyacea), a classification that emphasises the differences between these two groups of bivalves, although it can justifiably be criticised for its proliferation of superfamilies. The Afghanodesmatacea contains a single family Afghanodesmatidae which is based on an Ordovician genus, and is irrelevant to the present discussion, but the other superfamilies all include extant representatives. The Manzanellacea comprise the Manzanellidae and Nucinellidae, and the Huxleyiacea the single family

Huxleyidae Scarlato and Starobogatov, 1971. The type genus of Huxleyidae, *Huxleyia* Adams, 1860, is so similar to *Nucinella* as to rule out the necessity for familial segregation, let alone the recognition of a distinct superfamily.

Scarlato and Starobogatov's subdivision of the Solemyina into two superfamilies (each with a single family) is unwarranted on present evidence, although they are justified in proposing the family Acharacidae for solemyaceans without an internal ligament and having the external ligament supported by nymphs (Scarlato and Starobogatov 1985, p. 35). The Acharacidae includes the extant genus *Acharax* Dall, 1908 and the Japanese Miocene genus *Adulomya* Kuroda, 1931.

2 Nuculidae.

The supraspecific classification of this large family has received relatively little attention from taxonomists, probably because of the conservative nature of the nuculid shell. There have in fact been remarkably few significant contributions to our understanding of nuculid classification since Schenck's very useful summary of the family (1934), the most important being the brief (and usually overlooked) paper by Van de Poel (1955). Most workers who have discussed the classification of the family have made much of the presence or absence of marginal crenulations (see review in Schenck 1934). Schenck himself seems to have placed little value on this character, as he classed *Ennucula* Iredale, 1931 as a subgenus of *Nucula*, even though he correctly observed that the former taxon has a smooth margin, whereas *Nucula* has well-developed marginal crenulations. A more fundamental subdivision of the family, based on shell structure, was proposed by Van de Poel (1955), who recognised two major groups – one, typified by *Nucula*, in which there is a subsurface layer of fine radial rods or prisms of rectangular section, and another, including the Mesozoic genus *Nuculoma*, lacking such radial elements. These structural elements have been studied in detail by Bøggild (1930, p. 249), and by Taylor et al (1969, pp. 39–41, 65–65) who refer to them as 'first-order prisms' each of which is composed of minute, needle-like 'second-order' prisms which diverge in a feather-like fashion from its longitudinal axis. The inner face of each first-order prism bears a longitudinal flange which projects into the middle (lenticular nacreous) layer. The middle layer thins distally thus leaving the ends of the flanges exposed as marginal crenulations or denticles.

Van de Poel proposed that all nuculids, with the exception of *Acila* and *Truncacila*, should be assigned to *Nucula* or *Nuculoma*, depending on whether radial structural elements are present or absent. Other genus-group taxa that had been proposed in the Nuculidae were classed as subgenera of either *Nucula* or *Nuculoma*. This arrangement is far too conservative, however, and leads to several disparate taxa with little more in common than their shell structure, being included in the same genus. I therefore propose that the Nuculidae be subdivided into two subfamilies, Nuculinae with radial elements, and a new subfamily Nuculominae, without such elements.

These subfamilies contain the following extant nominal genus-group taxa –

Nuculinae

Nucula Lamarck, 1799
Lamellinucula Schenck, 1944
Linucula Marwick, 1931
Deminucula Iredale, 1931
Pronucula Hedley, 1902
Rumptunucula Bergmans, 1978

Nuculominae

Ennucula Iredale, 1931
Brevinucula Thiele, 1934
Austronucula Powell, 1939
Condylonucula Moore, 1977

The place of *Acila* and *Truncacila* in this scheme is uncertain. Some species have smooth margins but others, including the type species of *Acila*, *A. divaricata* (Hinds), have crenulate

margins although the subsurface prisms responsible are divarcating rather than truly radial. The implication is that the divaricate-sculptured nuculids are polyphyletic, a view proposed by Quenstedt (1930) but rejected by Schenck (1934, p. 14, 1936, p. 17), and requiring investigation by someone with access to a large collection of species.

Allen and Hannah do not discuss three of the taxa listed above (viz. *Linucula*, *Rumptonucula* and *Condylonucula*), and their treatment of some of the other taxa is unsatisfactory. These taxa are discussed individually below –

a) *Lamellinucula*. Allan and Hannah synonymise this taxon with *Nucula* without comment. The type species, *Nucula tamatavica* Ohdner, 1943 (Recent, Madagascar) differs from *N. nucleus* (Linné) and other species of *Nucula* (s.s.) in having very prominent commarginal sculpture, and in having a more strongly oblique chondrophore with its upper edge fused to the ventral edge of the hinge plate rather than freely projecting below it (Schenck 1944). Although these may seem relatively minor differences they are taxonomically important in a family where shell characters are so conservative. Nuculids closely resembling *N. tamatavica* are recorded back to the Middle Eocene in New Zealand, and in some faunules they are associated with almost smooth nuculines that are referable to *Nucula* (s.s.). This suggests that *Lamellinucula* is worth recognising – if only as a subgenus of *Nucula* – but it should be emphasised that not all nuculines with definite commarginal sculpture are assignable to this taxon.

b) *Pronucula*. Although Allen and Hannah class this as a subgenus of *Nucula*, the type species, *P. decorosa* Hedley, 1902 (Recent, south-east Australia), differs from typical species of *Nucula* not only in its hinge characters, but also in the nature of the periostracum. In most nuculids the periostracum is smooth or weakly ridged, but *P. decorosa* has radial rows of small tubular projections (see Bergmans 1978, fig. 43). Bergmans (1978, p. 677) synonymises *Pronucula* with *Nucula*, but the unusual periostracum, minute size, and the distinctive hinge (particularly the gap between the tiny chondrophore and the teeth) warrant recognition of *Pronucula* as a distinct genus. It is unfortunate that many minute nuculids with little in common apart from their size have been assigned to *Pronucula* – this has had the undesirable effect of blurring the concept of the taxon. Some of these species probably belong in *Deminucula* (see below).

c) *Rumptonucula*. This was proposed by Bergmans (1978, pp. 710–711) for *Pronucula vincentiana* Cotton & Godfrey, 1938 (Recent, South Australia), which differs from other small nuculines in having a very deeply sunken chondrophore, and one or more small ‘primary’ teeth on either side of the chondrophore. The taxon (treated as a genus by Bergmans) is monotypic.

d) *Linucula*. This taxon (which is worthy of generic rank) differs from all other nuculids in having subsurface elements on the lunule and escutcheon. These elements are very similar to those on the rest of the shell but are finer, and instead of being arranged radially, diverge from the radial elements. As a result the fine crenulations marking the distal ends of these divergent elements extend around the dorsal margins almost to the beak, and in well-preserved shells this is the simplest way of distinguishing *Linucula* from other nuculines, all of which have smooth dorsal margins. Although the type species of *Linucula*, *L. ruatakiensis* (Marwick, 1926) is from the Late Miocene of New Zealand, there are at least three extant New Zealand species, including *L. recens* Dell, 1956. (*Nucula gallinacea* Finlay, 1930, referred to *Linucula* by Dell (1956a, p. 28) lacks the characteristic shell-structure and is elsewhere made the type of a new genus *Varinucula* (Maxwell 1988, p. 35).) *Linucula* is the most speciose

nuculid genus in the New Zealand Cenozoic, and is also recorded from the modern Chilean fauna (as *L. pisum* (Sowerby, 1832); Dell 1964, p. 144). The species currently assigned to *Linucula* vary considerably in size, shape, sculpture and hinge details, and the genus will probably eventually require subdivision.

e) *Deminucula*. Allen and Hannah class this as a synonym of *Tindaria*; in the 'Treatise' (Moore 1969, p. N235) it is ranked as a subgenus of that taxon. It is in fact a nuculid, and its incorrect assignment apparently results from the poor preservation of the type material of the type species, *D. praetenta* (Iredale, 1924) (Recent, New South Wales). Schenck (1934, p. 44) noted that two workers in the British Museum (Natural History), where the type specimens are stored, could 'find no vestige of a chondrophore', and for this reason he doubted that *Deminucula* belongs in the Nuculidae. Iredale (1939, p. 234), however, pointed out that a chondrophore is present in well-preserved specimens, even if it seems to be absent from some dead shells. Bergmans (1978, pp. 689–690, figs. 24–26) redescribed *D. praetenta*, provided fine illustrations of the lectotype, and confirmed its nuculid affinities. Although he synonymised *Deminucula* with *Nucula*, I have recently advocated its use for small, smooth or almost smooth, rather robust nuculines with a minute resilifer that does not project below the hinge plate (Maxwell 1988, p. 36). Besides the type species *Deminucula* includes several modern Australian species and a few fossil forms from New Zealand.

f) *Brevinucula*. Allen and Hannah (1986) class this as a subgenus of *Nucula*, and note in their diagnosis 'radial elements not obvious'. As far as I can judge from published descriptions and figures of the type species (eg. Schenck 1934, pl. 5, figs. 2, 2c) and from examination of a remarkably similar species from the Early Miocene of New Zealand, the only 'radial elements' present are very weak surface striae. The absence of marginal crenulations indicates a lack of subsurface radial elements, so *Brevinucula* should be included in the Nuculominae.

g) *Nuculoma*. Allen and Hannah class '*Nuculopsis* Woodring, 1925'; *Leionucula* Quenstedt, 1930; *Ennucula* Iredale, 1931; and *Austronucula* Powell, 1939 as synonyms of this genus. (Woodring (1973, p. 489) proposed the replacement name *Lissanucula* for *Nuculopsis* Woodring, 1925 (non Girty, 1911 nec Rollier, 1912).) The type species of *Nuculoma*, *N. castor* Orbigny, 1849 (Jurassic, France), has a more rounded posterior end than most nuculids, has very prominent, terminal umbones, and has well-developed commarginal sculpture. It does not closely resemble the type species of any of the taxa listed above, and in my opinion *Nuculoma* is not an appropriate location for any extant nuculid.

Ennucula has been regarded as a full genus by some workers (e.g. Dell 1956b, p. 11, Soot-Ryen 1959, p. 12), but others have classed it as a subgenus of *Nucula* (Schenck 1934, p. 36), or of *Nuculoma* (Van de Poel 1955), or as a synonym of *Leionucula* (Keen in Moore 1969, p. N231, Thiele 1934, p. 786). The type species of *Ennucula*, *E. obliqua* (Lamarck, 1819) (Recent, Australia) (Schenck 1934, pl. 3, figs. 4, 4a) is smooth and ovate with a subangled posterior end and low umbones and shows no particular resemblance to *Nuculoma castor*. It is, however, not unlike the type species of *Leionucula* Quenstedt, 1930; *L. albensis* (Orbigny, 1844) (Early Cretaceous, France) in shape and lack of definite sculpture, but differs in having a much less strongly impressed escutcheon and a less well defined anterior area. The hinge of *L. albensis* (apparently a rare species) has not been figured to my knowledge, and Schenck's description (1934, p. 34 footnote) is insufficiently detailed for a meaningful comparison with other nuculid hinges. Until such time as more is known about the internal characters of *L. albensis* and other Cretaceous members of *Leionucula*, *Ennucula* should be retained as a full genus for the larger Cenozoic and Recent nuculomines.

Austronucula was proposed for a minute nukulid measuring only 1.15×1 mm, devoid of external sculpture or radial elements, and having relatively few hinge teeth (Powell 1939, pp. 220–221). Besides the type species, *A. schencki* Powell, 1939 (Recent, southern New Zealand), the genus is represented in the modern fauna by *A. galathea* Dell, 1956 (Tasman Sea), and possibly by an undescribed species from New South Wales (Bergmans 1978, p. 710, figs, 36, 37, as '*Nucula* species'). *Austronucula* cannot be plausibly regarded as a synonym of *Nuculoma*.

h) Condylonucula. This taxon was proposed by Moore (1977, p. 123) for two extremely small bivalves from the western Caribbean, *Condylonucula cynthiae* Moore (type species) and *C. maya* Moore. Distinguishing characters include the small size (Moore estimates that they mature at about 0.5–0.6 mm in length making them among the smallest known bivalves), the large, prominently ridged and pitted prodissoconch, the lack of sculpture other than growth ridges, and the absence of radial elements. The reported absence of nacre is also unusual and may indicate that *Condylonucula* has been derived paedomorphically from a larger nukulid. Another possibility is that *Condylonucula* is not a nukulid, but a philobryid related to *Aupouria* Powell, 1937. The absence of a vertically striate cardinal area would appear to rule out this possibility, however.

3 Tindariidae

Should be attributed to Verrill & Bush, 1897 who proposed a subfamily Tindariinae of Ledidae (=Nuculanidae) (Verrill & Bush 1897, p. 58). The words 'occasionally with radial lines' should be omitted from the diagnosis of the family, as this results from the unwarranted inclusion of *Deminucula praetenta* in *Tindaria* (see above).

4 Saturniidae

Saturnia (which should be attributed to Seguenza, 1877 rather than to Dall, 1881) is a junior homonym of *Saturnia* Schrank, 1802. McAlester (in Moore 1969, p. N235) accepted *Saturnia* Seguenza as the correct name for these bivalves in the first volume of the Bivalve section of the 'Treatise', but corrected his error in the 'Errata and Revisions' at the end of volume 3 (pp. N1214–1215). The valid name for the family is Neilonellidae Allen, 1978 (pp. 390, 392).

Allen & Hannah follow McAlester (in Moore 1969, p. N235) in synonymising *Austrotindaria* Fleming, 1948 with '*Saturnia*' (i.e. *Neilonella*). The relationship between these taxa needs clarification, however. Fleming (1948, p. 73) listed several differences between the respective type species, the most important being the nature of the ligament – this is opisthodontic in *A. wrighti* Fleming, 1948 (Recent, New Zealand) but amphidetic in *N. corpulenta* Dall, 1881 (Recent, Caribbean). Further study is required to determine if these differences are consistent.

5 Lametilidae

If *Phaseolus* is considered to be confamilial with *Lametila* then the correct family name will be Phaseolidae Scarlato & Starobogatov, 1971. These authors, however, recognise both Phaseolidae and Lametilidae and place them in a superfamily Phaseolacea (Scarlato & Starobogatov 1985, pp. 17, 33), although there seems to be little justification for such an action.

6 Ledellinae

This subfamily should be attributed to Allen, 1978 (p. 392). Zealedidae Scarlato & Starobogatov, 1979, based on *Zealeda* Marwick, 1924, is presumably a synonym. Allen & Hannah synonymise *Magaleda* Iredale, 1929 with *Ledella*, but I have elsewhere synonymised it with *Zealeda*, which is otherwise known by several New Zealand Cenozoic species

(Maxwell 1988, p. 40). *Zealeda* differs from *Ledella* mainly in the presence of distinct radial sculpture, a rare character in the Nuculanidae.

7 Nuculaninae

This subfamily must of course be attributed to H. & A. Adams, 1858, not to Allen & Sanders, 1982.

a) Nuculana. Allen & Hannah take a very broad view of this taxon and attempt to justify it by referring to the 'continuum of form' they say exists among the modern species. Some convergence in shell form is only to be expected in a relatively conservative group like the nuculanids, and this means that very careful attention must be paid to the finer details of shell shape, sculpture (including microsculpture where present), hinge and ligament, and of course, anatomy. Some of the nominal taxa treated as synonyms of *Nuculana* by Allen & Hannah are probably not worth recognising, but others cannot be dismissed so easily. For instance, *Scaeolea crassa* (Hinds, 1843), the type species of *Scaeolea* Iredale, 1929, differs markedly from the type species of *Nuculana*, *N. pernula* (Müller, 1771), in having a narrowly pointed rather than a truncate rostrum, in having prominent commarginal sculpture over most of the shell, in the presence of longitudinal ridges on the escutcheon, and in having a pronounced radial groove margining the rostrum. Several other species with similar shell characters are recorded from the Neogene and Recent of southern Australia and constitute a well-defined group that is worth separating from *Nuculana* (s.s.), at least at the subgeneric level. In some respects *Scaeolea* is much more like *Saccella* (see below) than *Nuculana*.

b) Jupiteria. This is worth recognising as a full genus rather than as a subgenus of *Nuculana*. Allen & Hannah interpret it in a very broad sense to include *Saccella*, but the two groups are quite distinct and have been since at least the Middle Eocene. Species of *Jupiteria* are subtrigonal, have a narrowly rounded rostrum and a rounded postero-umbonal ridge, are devoid of sculpture other than weak commarginal ridges or grooves, and have a shallow pallial sinus. Those of *Saccella*, by contrast, are elongate-ovate with a narrow (or even sharp) rostrum, and a more sharply defined postero-umbonal ridge, typically have sculpture of prominent commarginal ridges (although these have become secondarily obsolete in certain late Cenozoic New Zealand species), and have a considerably deeper pallial sinus than in *Jupiteria*.

c) Poroleda Hutton, 1893 (incorrectly attributed to Tate, 1893 in the 'Treatise', p. N237) suffers the unenviable fate of being synonymised with both *Jupiteria* Bellardi, 1875 and *Propeleda* Iredale, 1924. *Poroleda* most emphatically has nothing to do with *Jupiteria*, even in the unacceptably broad sense in which the latter taxon is interpreted by Allen & Hannah. The type species, *P. lanceolata* (Hutton, 1885) (Pleistocene-Recent, New Zealand) is very elongate and inequilateral, has a bluntly truncate rostrum and a deep pallial sinus, and is almost smooth. The hinge is very distinctive – the posterior teeth are long, lamellar, subhorizontal and imbricate; the anterior teeth are superficially similar, but close inspection shows that, except for the proximal ones, the teeth are of typical nuculanid form (ie of chevron cross-section) except that the lower (ventral) limbs have become extremely shortened and inconspicuous. The resilifer is narrow and very oblique, and extends for some distance below the posterior part of the hinge. *Propeleda eniscula* (Angas, 1877) (Recent, Australia), the type species of *Propeleda*, is similar to *Poroleda lanceolata* in shape, but has distinctly chevron-shaped teeth in both anterior and posterior series, and has a less oblique resilifer. It should be noted that the illustration in the 'Treatise' (figs. A6,9a,b), supposedly of *Propeleda eniscula*, is actually of *Lamellileda typica* Cotton, 1930, the type species of *Lamellileda*

Cotton, 1930. This differs from *Poroleda lanceolata* in having lamellar anterior teeth, but in view of the fact that these teeth are barely chevron-shaped in the latter species, this difference can hardly be claimed to be of supraspecific importance, and I accordingly synonymise *Lamellileda* with *Poroleda*. Allen & Hannah recognise *Lamellileda* as a distinct genus in the Siliculidae, whereas Puri (in Moore 1969, p. N237) and Habe (1977, p. 23) synonymise it with *Propeleda*. On the other hand, *Tenuileda* Habe, 1977 (pp. 21, 23) seems to be based on a species of *Propeleda*.

Poroleda is probably best regarded as a nuculanid that has been derived from *Propeleda* or a related taxon by changes in the shape of the teeth, but the two groups have been distinct since at least the Early Miocene, and possibly since the Middle Eocene. Scarlato and Starobogatov (1985, p. 34) have proposed a new family Poroledidae for *Poroleda* and *Propeleda*, but it seems to be totally redundant. (They have also erected the family Adranidae for the unusual genus *Adrana*, but this too is of very dubious value.)

8 Yoldiidae

a) This family should be attributed to Habe, 1977 (p. 25), and Yoldiellinae to Allen, 1978 (p. 392). However, if *Sarepta* is regarded as confamilial with *Yoldia*, the correct family name will be Sareptidae A. Adams, 1860. Habe (1977, pp. 16, 25) accepts Sareptidae (with Pristiglomidae Sanders & Allen, 1973 as a synonym) as a family in its own right, but classes Yoldiinae as a subfamily of Nuculanidae. Scarlato and Starobogatov (1985, p. 34) also recognise Sareptidae and place it, Pristiglomidae and Zealedidae in a new superfamily Sareptacea, apparently based solely on shell characters. There is too little information on the anatomy of *Sarepta* to give much credence to this proposal, even though *Sarepta* superficially resembles *Pristigloma* in shell shape. The evidence presented by Saunders and Allen (1973, pp. 239–240) indicates very strongly that Pristiglomidae are most closely related (at least in phenetic terms) to Nuculidae; *Sarepta*, on the other hand seems to have more in common with typical nuculanaceans, despite its relatively rounded outline.

b) Ovaleda. Allen & Hannah regard this as a distinct genus, even though most workers regard it as a synonym of *Sarepta* (e.g. Cotton 1961, p. 35, Habe 1977, p. 16, Puri in Moore 1969, p. N239, Thiele 1934, p. 788). Examination of numerous specimens of *S. tellinaeformis* Hedley, 1901 (Recent, New South Wales) – the type of species of *Ovaleda* – failed to reveal any important shell characters that would serve to distinguish it from species of *Sarepta*. Unless some significant anatomical differences can be found, *Ovaleda* should be synonymised with *Sarepta*.

9 Siliculidae

On page 236 Allen and Hannah accept *Silicula* Jeffreys, 1879 as a valid genus, even though they include it in the synonymy of *Phaseolus* Monterosato, 1875 on p. 231, apparently following Puri (in Moore 1969, p. N238). Scarlato and Starobogatov (1979, p. 17, 33) class Siliculidae Allen & Sanders, 1973 as a synonym of Radiidentidae Egorova & Starobogatov, 1975 which they maintain as a family distinct from Phaseolidae Scarlato & Starobogatov, 1971. The type genus, *Radiidens* Egorova & Starobogatov, 1975 was proposed as a replacement for *Silicula* Jeffreys, 1879 on the assumption that the latter name was in turn an unnecessary substitution for *Phaseolus*. The nomenclatural history of *Phaseolus* and *Silicula* is in fact rather confused and clearly in need of clarification.

Phaseolus was first used in zoological nomenclature by Monterosato (1875, p. 4) who attributed the name to 'Jeffreys ms'; the sole species included in the genus was '*Phaseolus ovatus* Jeffr. ms'. Several authors, including Dell (1955, p. 127), have considered these names to be *nomina nuda* as published by Monterosato, and have cited the author as 'Seguenza,

1877'; however, Allen and Sanders (1973, pp. 265–266) pointed out that Monterosato had provided a brief description of *Phaseolus* and accordingly attributed the name to him. Jeffreys (1879, p. 573) apparently was unaware of the use of *Phaseolus* by Monterosato and Seguenza when he proposed the new genus *Silicula* with the comment 'I at first thought of *Phaseolus* as an appropriate generic name; but as that is so well known in Botany, I have substituted *Silicula* for the Mollusk'. Prior use of a generic name for a plant of course does not rule out its use in zoological nomenclature, so *Silicula* could be construed as an unnecessary replacement name for *Phaseolus* (Jeffreys MS) Monterosato, 1875 despite the fact that Jeffreys did not know the latter name had been published. However, most authors (e.g. Verrill and Bush 1879, pp. 62, 63, Thiele 1934, pp. 789, 790, Allen & Sanders 1973, p. 266) have accepted *Phaseolus* and *Silicula* as distinct genera because their respective type species, *P. ovatus* and *S. fragilis* are so different as to make it highly unlikely that they are congeneric (see Allen and Sanders 1973, figs. 1 and 2 for illustrations of these species). Dell (1955, p. 128) and Allen and Sanders (1973, p. 264) cited *S. fragilis* as the type species of *Silicula* by monotypy, but Jeffreys in fact quite explicitly selected *S. fragilis* as the type species. Puri (in Moore 1969, p. N238) classed *Silicula* as a objective synonym of *Phaseolus*, but this of course is incorrect.) Nonetheless Jeffreys himself evidently thought that *P. ovatus* and *S. fragilis* are closely related for he comments 'The Abbé Brugnone and the Marchese di Monterosato have discovered in the Tertiary Formation at Ficcarazzi, near Palermo, a minute fossil species of *Silicula*, for which the name *ovata* is proposed' (Jeffreys 1879, p. 573).

The *Phaseolus/Silicula* problem is far from clear-cut, but the conventional interpretation, i.e. that *Silicula* and *Phaseolus* are different taxa, does less violence to the status quo and is favoured here. *Radiidens* and Radiidentidae are therefore regarded as unnecessary replacement names for *Silicula* and Siliculidae.

SYNOPSIS OF CLASSIFICATION

In the following table I have attempted to reconcile Allen & Hannah's suprageneric classification of extant protobranchs with that proposed by Scarlato & Starobogatov, paying due attention to the valid names and correct authorship for the taxa concerned, but rejecting most of the superfamilies recognised by the latter authors as being unjustified by the available information.

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TABLE 1
Synopsis of Classification

| Allen & Hannah (1986) | Scarlato & Starobogatov (1979, 1985) (Extant taxa only listed. Terminations of ordinal and superfamilial names emended to conform with those used by Allen & Hannah) | Classification adopted here |
|---|--|--|
| Order Solemyoida Dall, 1889 | Order Solemyoida Newell, 1965 | Order Solemyoida Dall, 1889 |
| Family Solemyidae Gray, 1840 | Suborder Solemyina Newell, 1965 | Suborder Solemyina Dall, 1889 |
| Family Nucinellidae Vokes, 1956 | Superfamily Solemyacea H. & A. Adams, 1857 | Superfamily Solemyacea Gray, 1840 |
| | Family Solemyidae H. & A. Adams, 1857 | Family Solemyidae Gray, 1840 |
| | Superfamily Acharacacea Scarlato & Starobogatov, 1979 | Family Acharacidae Scarlato & Starobogatov, 1979 |
| | Family Acharacidae Scarlato & Starobogatov, 1979 | Suborder Nucinellina Scarlato & Starobogatov, 1971 |
| | Suborder Nucinellina Scarlato & Starobogatov, 1971 | Superfamily Manzanellacea Chronic, 1952 |
| | Superfamily Manzanellacea Chronic, 1952 | Family Manzanellidae Chronic, 1952 |
| | Family Nucinellidae Vokes, 1956 | |
| | Superfamily Huxleyiacea Scarlato & Starobogatov, 1971 | |
| | Family Huxleyidae Scarlato & Starobogatov, 1971 | |
| Order Nuculoida Dall, 1889 | Order Nuculoida Dall, 1889 | Order Nuculoida Dall, 1889 |
| Superfamily Nuculacea Gray, 1824 | Suborder Nuculina Dall, 1889 | Superfamily Nuculacea Gray, 1824 |
| Family Pristiglomidae Sanders & Allen, 1973 | Superfamily Nuculacea Gray, 1824 | Family Nuculidae Gray, 1824 |
| Family Nuculidae Gray, 1824 | Family Nuculidae Gray, 1824 | Subfamily Nuculinae Gray, 1824 |
| Superfamily Nuculanacea Gray, 1824 | Superfamily Nuculanacea H. & A. Adams, 1858 | Subfamily Nuculominae nov. |
| Family Tindariidae Sanders & Allen, 1977 | Family Nuculanidae H. & A. Adams, 1858 | Family Pristiglomidae Sanders & Allen, 1973 |
| Family Saturniidae Allen & Hannah, 1986 | Family Adranidae Scarlato & Starobogatov, 1979 | Superfamily Nuculanacea H. & A. Adams, 1858 |
| Family Lametilidae Allen & Sanders, 1973 | (?) Family Poroledidae Scarlato & Starobogatov, 1979 | Family Nuculanidae H. & A. Adams, 1858 |
| Family Nuculanidae H. & A. Adams, 1858 | Superfamily Sareptacea A. Adams, 1860 | Subfamily Nuculaninae H. & A. Adams, 1858 |
| Subfamily Ledellinae Allen & Sanders, 1982 | Family Sareptidae A. Adams, 1860 | |
| Subfamily Spinulinae Allen & Sanders, 1978 | Family Pristiglomidae Sanders & Allen, 1973 | Subfamily Ledellinae Allen, 1978 |
| | Family Zealedidae Scarlato & Starobogatov, 1979 | Subfamily Spinulinae Allen & Sanders, 1982 |
| | Superfamily Ctenodontacea Wöhrmann, 1893 | Family Sareptidae A. Adams, 1860 |
| | Family Tindariidae Verrill & Bush, 1897 | Subfamily Sareptinae A. Adams, 1860 |
| | Superfamily Malletiacea H. & A. Adams, 1858 | Subfamily Yoldiinae Habe, 1977 |
| | Family Malletiidae H. & A. Adams, 1858 | Subfamily Yoldiellinae Allen, 1978 |

| | | |
|---|--|--|
| Sanders, 1982 | Suborder Radiidentina Scarlato & Starobogatov, 1975 | Family Tindariidae Verrill & Bush, 1897 |
| Subfamily Nuculaninae Allen & Sanders, 1982 | Superfamily Radiidentacea Egorova & Starobogatov, 1975 | Family Neilonellidae Allen, 1978 |
| Family Yoldiidae Allen & Hannah, 1986 | Family Radiidentidae Egorova & Starobogatov, 1975 | Family Mallettiidae H. & A. Adams, 1858 |
| Subfamily Yoldiinae Allen & Hannah, 1986 | Superfamily Phaseolacea Scarlato & Starobogatov, 1971 | Family Phaseolidae Scarlato & Starobogatov, 1971 |
| Subfamily Yoldiellinae Allen & Hannah, 1986 | Family Phaseolidae Scarlato & Starobogatov, 1971 | Family Lametilidae Allen & Sanders, 1973 |
| Family Siliculidae Allen & Sanders, 1973 | Family Lametilidae Allen & Sanders, 1973 | |
| Family Mallettiidae H. & A. Adams, 1858 | | |

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A NEW SPECIES OF *MEDUSAFISSURELLA* (GASTROPODA: FISSURELLIDAE), A KEYHOLE LIMPET, FROM OMAN

KATHLEEN R. SMYTHE¹

(Accepted for publication, 21st May, 1988)

Abstract: This paper deals with a new species of *Medusafissurella* from Oman. It differs from the norm in having a shell that is not raised from the substratum at either end, the ribs not being scabrous and the size being much larger. Other differences from *Medusafissurella salebrosa* (Reeve) are discussed.

INTRODUCTION

A previously undescribed species of fissurellid gastropod has been recognised from the south of Oman. The shells have been collected over the years 1982 to 1985 by M. D. Gallagher, K. R. Smythe and others from the shores of Oman between Mirbat and Sadh and a few from the Kuria Muria Islands; they were found alive on just one occasion by a diver, as opposed to the littoral species, *Medusafissurella salebrosa* (Reeve, 1850), which is found in other localities in the Gulf and elsewhere. The species are assignable to *Medusafissurella*, the new genus erected by McLean and Kilburn, 1986, in that they have a similar mass of unbranched propodial tentacles, although they differ in many other respects.

***Medusafissurella gallagheri* sp nov.** (Pl. 8, figs. a–h; Pl. 9, fig. i)

The shell is conical in shape with the oval hole at the apex (apical opening or foramen) that is characteristic of the keyhole limpets (Fissurellidae). In side view (Pl. 8d) the height of the shell represents 40% of the total shell length, so it is fairly tall. The sides of the shell are even, but are affected by growth lines of irregular amounts so that unevenness may sometimes occur. The apical hole is regular, oval and is about equidistant from the ends. The base is flush with the substratum. The aperture is oval. The shell is slightly narrower at the anterior end, but not to the degree shown in *M. salebrosa*.

The radiating ridges are shallow and not scabrous; they number between about 46 and 50, are irregular in shape and the interspaces are also irregular, but much narrower in width. The lines of growth vary too, but strong as the ridges. The edges of the aperture are generally symmetrical, although some shells are found with irregular edges suggesting that they live in an uneven topography.

The outer surface of the shell is dark pink, but this can be obscured by marine algae. The outer layer is worn in beach specimens and can show rays of pink, cream or white in the shell layers below.

The interior of the shell is cream to pink; there is a horseshoe shaped muscle scar which has the opening towards the anterior, and a polished area of callus around the apical opening.

¹ 6 Blondell Drive, Bognor Regis, PO21 4BQ.

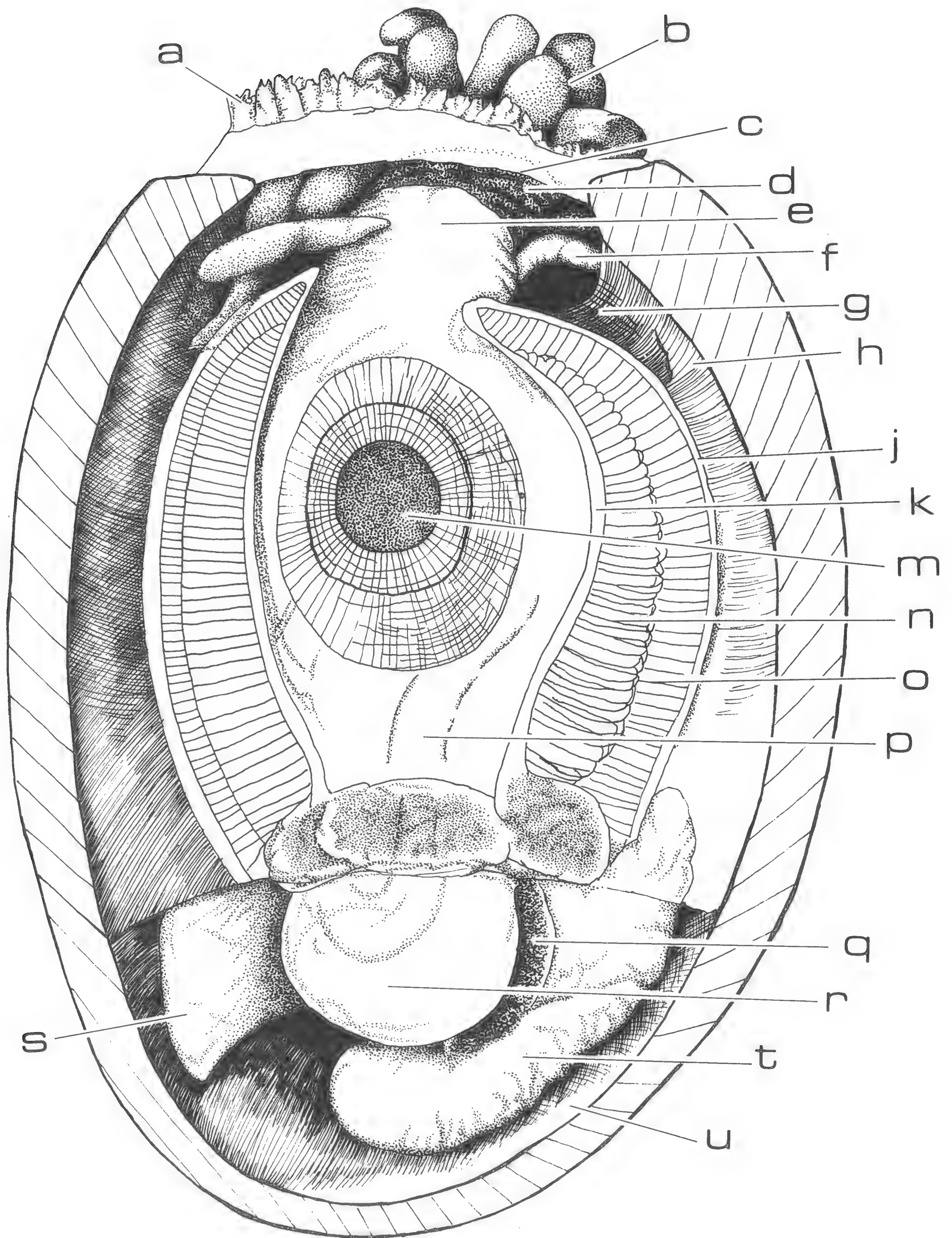


Fig. 1. *Medusafissurella gallagheri*: Dorsal view of the animal with shell removed.

Key: a, enlarged pallial tentacles on inner mantle fold; b, propodial tentacles (32 in all); c, edge of tear in mantle; d, front of foot; e, snout; f, cephalic tentacle bearing eye; g, shell muscle; h, afferent membrane; j, efferent vessel; k, afferent vessel; m, apical aperture; n, median part of triangular gill lamella; o, lateral part of the triangular gill lamella; p, anterior loop of intestine in body seen by transparency; q, right kidney; r, intestine; s, parasite; t, gonad/digestive gland; u, visceral haemocoel.

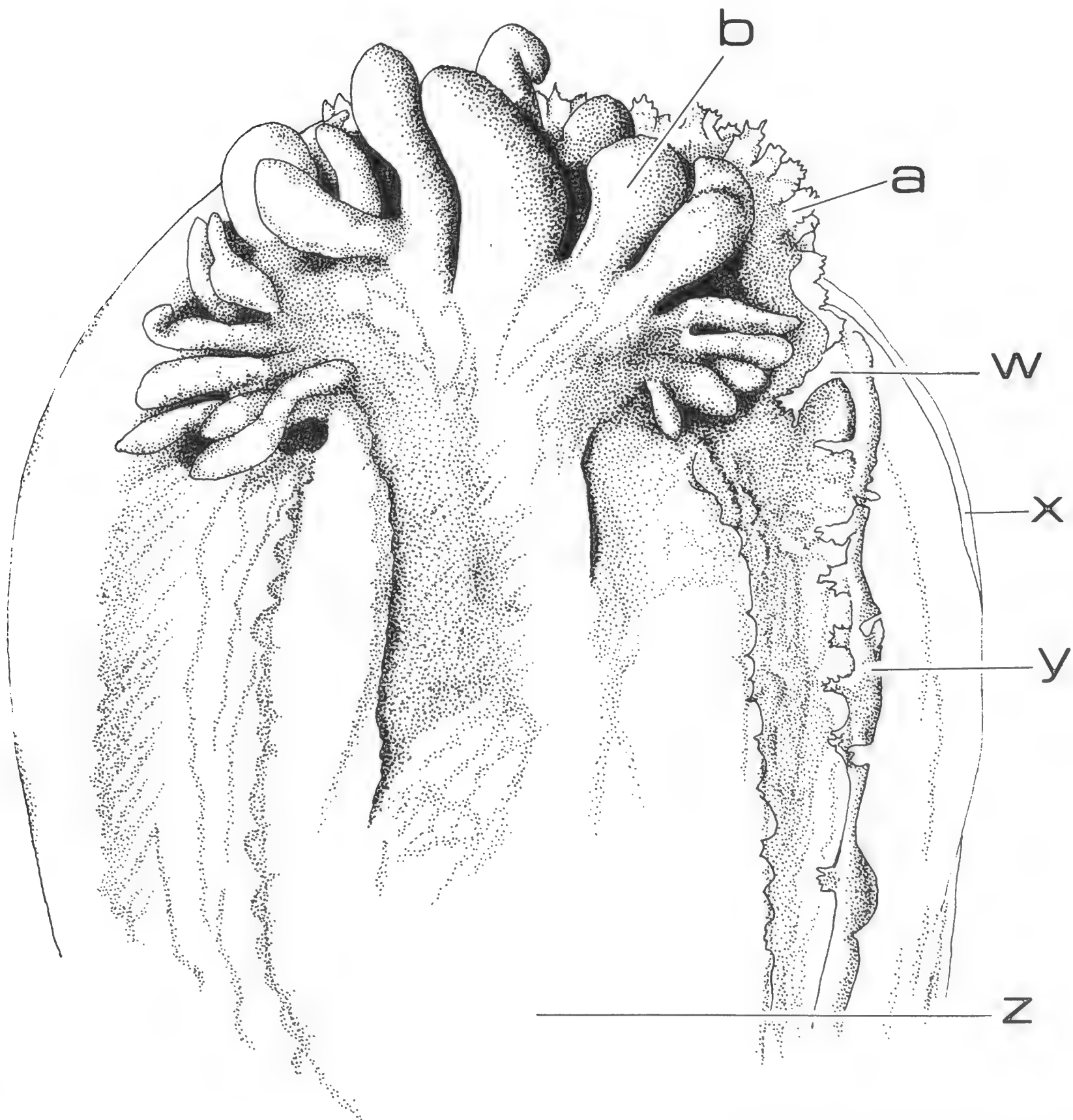


Fig. 2. *Medusafissurella gallagheri*: Ventral view showing propodial tentacles.

Key: a, enlarged pallial tentacles on inner mantle fold; b, propodial tentacles 932 in all); w, inner pallial fold with pinnate tentacles; x, outer pallial fold (secreting shell); y, middle pallial fold; z, sole of foot.

In size the shells found were up to 63 mm in length, 50 mm in breadth and 35 mm in height, the largest is the paratype in the Natural History Museum, Oman.

Type Specimens

The holotype is small; it measures 27 mm in length, 20 mm in breadth and 9 mm in height. It was collected live from under a small rock at about 2 m depth at low tide by John Michalakakis on March 29th 1985, in a small bay near Wadi Haart, Sadh, 55°09'E, 17°07'N. The National Museum of Wales Number is Z.1986.129.1. A deformed paratype is there as well; the number is Z.1986.129.2.

A paratype in the British Museum (Natural History) is larger; 34 mm × 23 mm × 10 mm; the number is 1986.246.

The remaining paratypes are in the collection of the Oman National Museum and a few remain in my collection and one in that of Doctor Bosch.

Habitat and Distribution

M. gallagheri was found alive on a stone offshore on only one occasion but shells were plentiful along the beaches from Mirbat to Sadh, 54°40' 17°00' to 55°09', 17°07'.

Animal

The animal has a yellow foot and dark brown edges to the mantle; it has light eyes with dark centres. The tentacles are a light brown. The propodial tentacles are deep brown in life and capable of considerable expansion. They are darkened on preservation.

At the anterior end of the foot are the propodial tentacles, which number 32. The inner, middle and outer pallial folds can be seen clearly (Fig. 2). The outer fold is simple and secretes the shell. The middle fold has slight indentations, the inner fold is complicated. It not only has deep primary tentacles along its length, but also has enlarged papillate tentacles around the mouth.

In ventral view (Fig. 1) can be seen the foot, snout, cephalic tentacles and eyes. The unfringed apical opening, right kidney, intestine and gonad/ digestive gland and the visceral haemocoel are clear, and so is the shell muscle. In the drawing the mantle has been removed to show the inner and outer lamellae of the ctendium, (the gill), the afferent membrane, and the afferent and efferent vessels with associated retractor muscles.

OTHER SPECIES OF *MEDUSAFISSURELLA*

Only one other species, *M. salebrosa*, is common living intertidally in Oman and elsewhere in the Indian Ocean. In *M. salebrosa* the anterior part of the shell is tilted downwards, and the dorsal edge up to accommodate the large foot which extends beyond the shell posteriorly (See Pl. 9, figs. i–m). It is flattened within. This is not as illustrated by McLean and Kilburn, 1986, who show the shell as tilted upwards both anteriorly and posteriorly, without the foot extended. The radiating ridges are sharp and separated by clearly defined sulci.

The eyes of a living animal are dark. The propodial tentacles number between 14 and 22, though the average is 18. They are light with dark brown or black edges and the foot is white.

The edges of the mantle are similar to those of *M. gallagheri* in many respects, but they have fewer tentacles, the inner mantle edge does not have tentacles along the sides though it has papillae over the mouth and the apical opening is fringed.

The contents of the gut suggest that the animal is omnivorous, sweeping up the gatherings of the tentacles into the mouth. There was similar material on the tentacles themselves, suggesting their function.

The interior of the shell is white in *M. salebrosa*, and the exterior is white to pale brown.

THE REMAINING FISSURELLIDS OF OMAN

The remaining species of fissurellids from Oman are placed in the genus *Diodora* spp., the emarginulids and a *Scutus*.

D. funiculata (Reeve, 1850) is a good Indo-Pacific species illustrated in Bosch and Bosch (1982). *D. jukesii* (Reeve) and *D. imbricata* (Sowerby) are synonyms of *D. funiculata*. *D. rueppelli* (Sowerby) also a good species and illustrated in Bosch and Bosch 1982. *D. singaporensis* is illustrated in Bosch and Bosch 1982 under the name *D. bombayana*. *D. townsendi* (Melvill) has not been not been illustrated since its original description in 1897. It is my opinion that the

latter species should be considered as a *Diodora* on account of the reticulate sculpture of the shell rather than the genus *Fissurella* in which it was originally placed.

Examinations of the type specimens of these species of *Diodora* in the British Museum (Natural History) lead to the discovery that *D. singaporensis* was the original of the *D. bombayana* group; furthermore that the syntypes of *D. bombayana* in actual fact consist of two species, and a note left by a former visitor indicated this discovery.

ACKNOWLEDGEMENTS

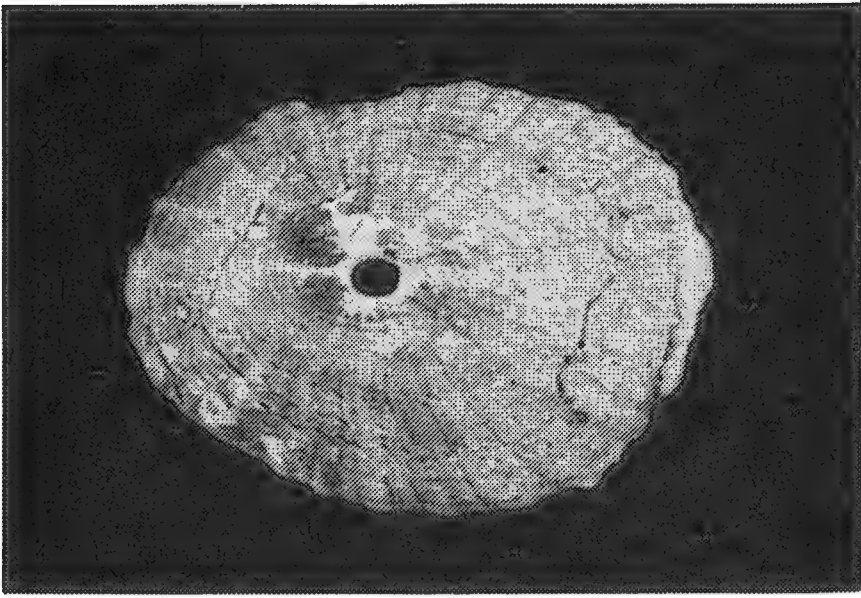
The author expresses her thanks to the Minister of National Heritage and Culture, Oman, and to his staff for all their help.

She is also grateful to Mr. E. Broadbent of the National Museum of Wales for his photographs of *M. gallagheri* and *M. salebrosa*, Dr. John Taylor, Dr. Vera Fretter and Professor A. Graham for comment, to Dr. Anne Hurst for the drawings, and most especially to Dr. June Chatfield for her kind help in writing this paper.

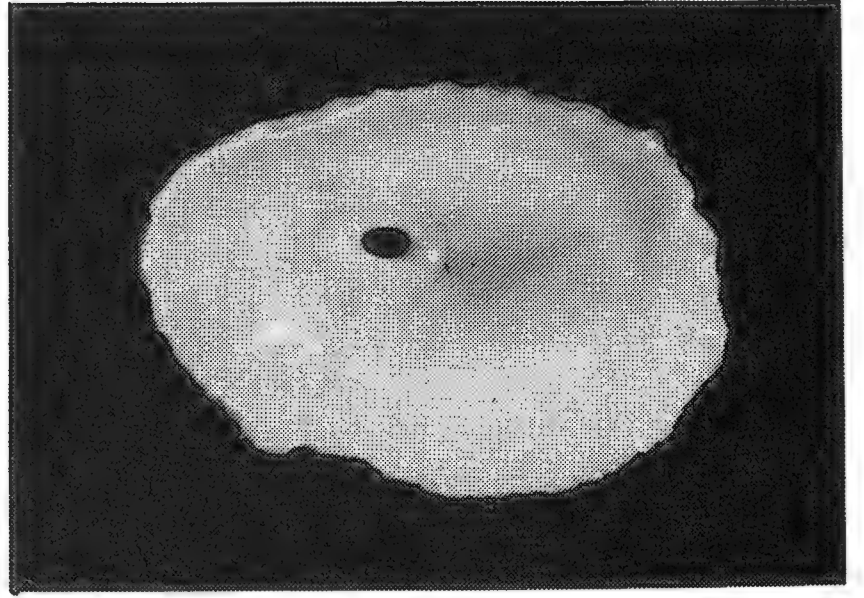
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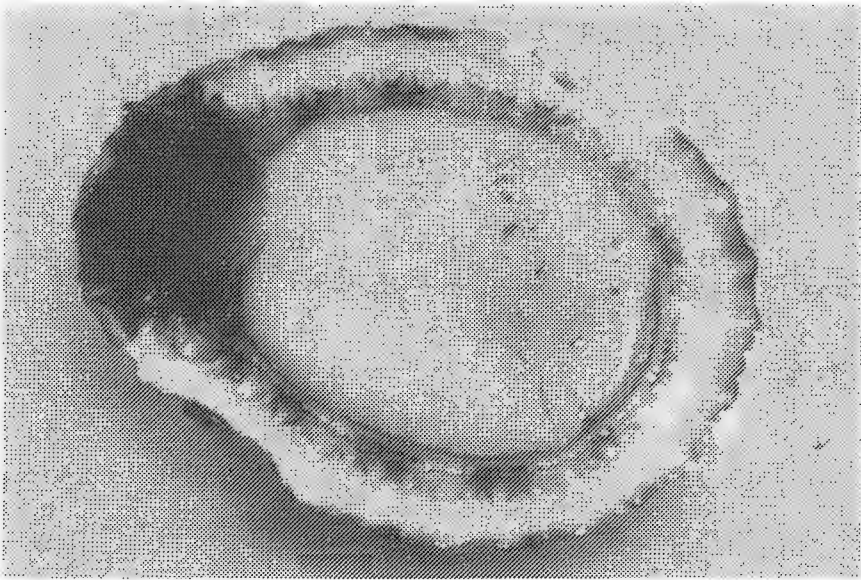
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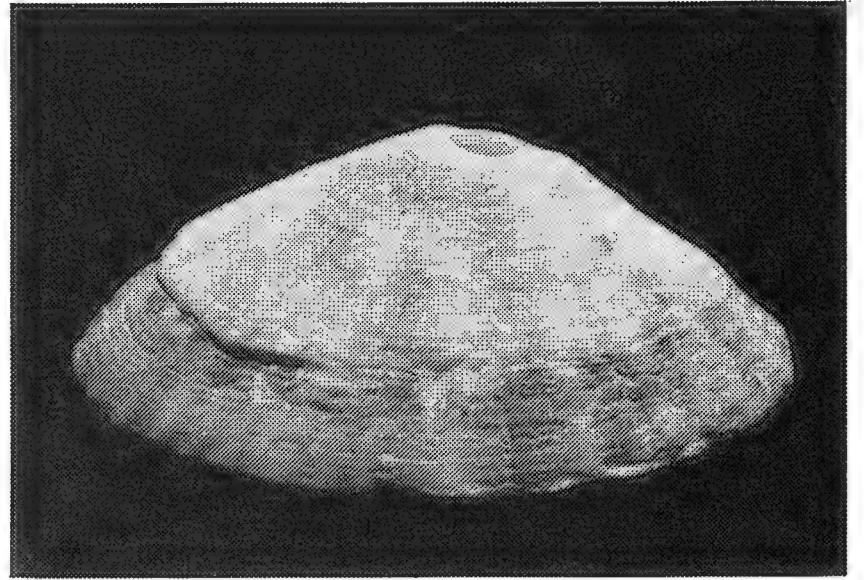
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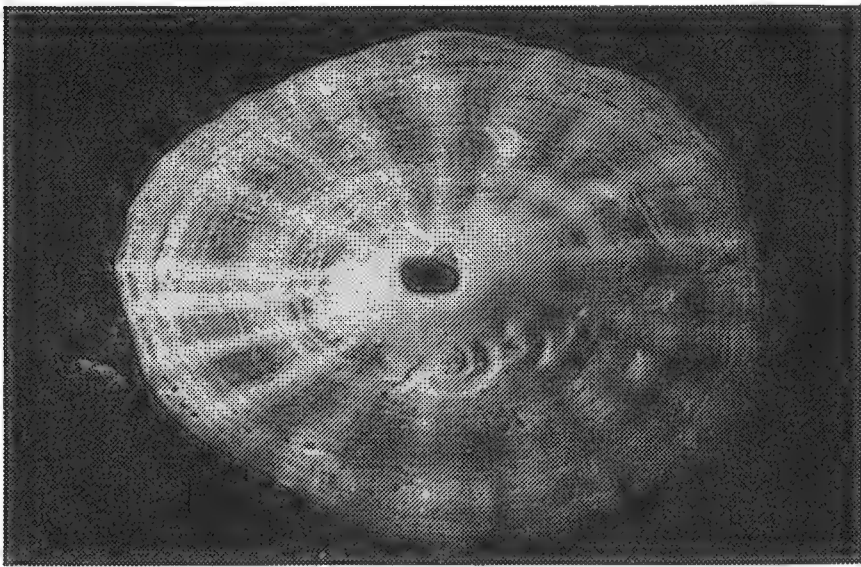
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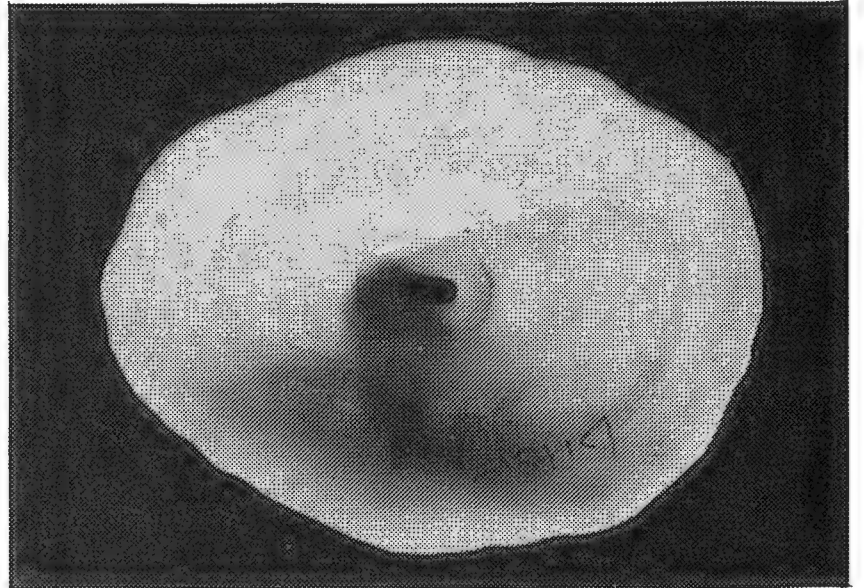
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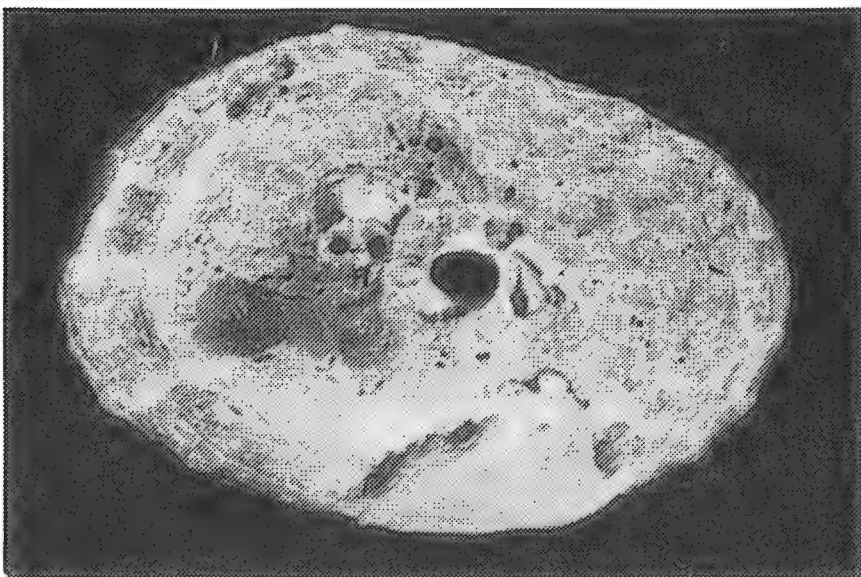
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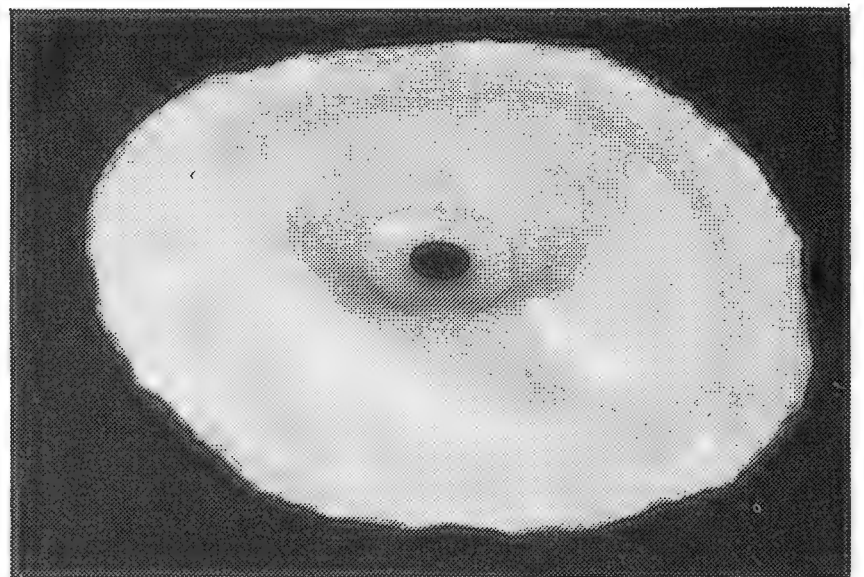
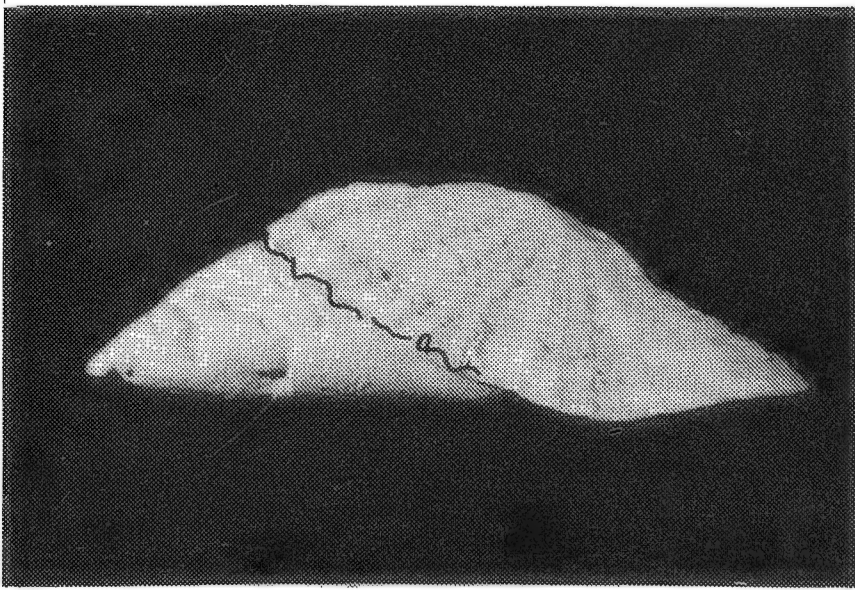


PLATE 8

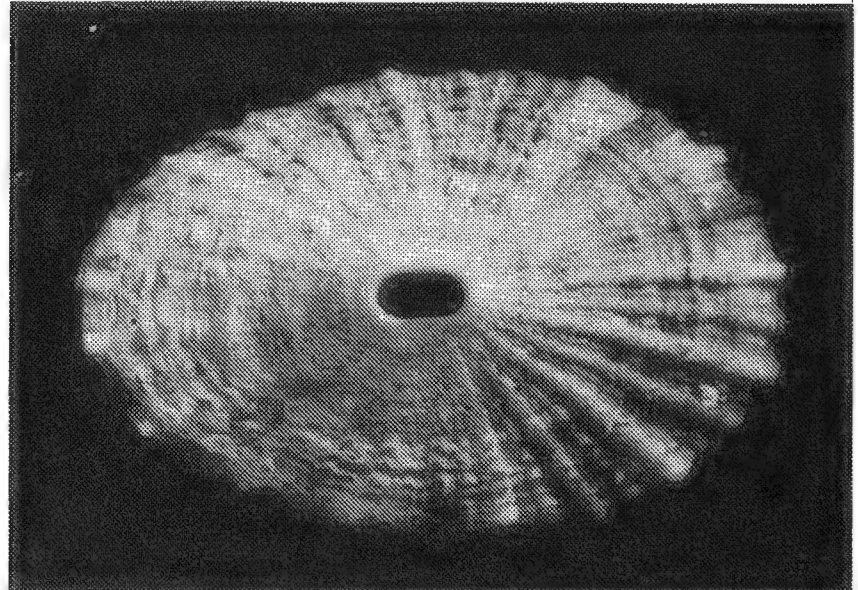
a & b *M. gallagheri* holotype, c *M. gallagheri* alive, d *M. gallagheri* side view showing flat undersurface, e & f *M. gallagheri* Smythe collection, g & h *M. gallagheri* deformed specimen.



i



j



k



l



m

PLATE 9

i *M. gallagheri* dead, j *M. salebroza* alive (animal modelled), k *M. salebroza* dead, l & m *M. salebroza* views of dead animal.

CONCHOLOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND, PROCEEDINGS

REPORT OF THE COUNCIL, 1987–1988

It is with regret that the Society has to announce the deaths of the following five members: Mr. W. Appleby, a life member since 1973; Mrs. M. P. Brockbank, a member since 1962; Dr. J. D. Hanley, a member since 1982; Mr. S. Harrison, a member since 1983, and Mrs. H. R. Jones, a member since 1962. The death was also announced of Mrs. W. Crowley, wife of our Vice-President and a member for many years.

The total membership of the Society now stands at 545, and is composed of the following categories: *Full members* 413, *Full Life Members* 31, *Family members* 32, *Family Life members* 6, *Junior members* 14, *Honorary members* 8, *Institutional members* 41. In addition there are 135 *Subscribers*. The society gave Honorary membership to Dr. Kerney and Mr. Negus in recognition of their services to the Society.

New members nominated and elected March 1987 – February 1988. Full members 23, *Family member* 1, *Junior members* 2.

Transfers There was one transfer from *Family* to *Full* membership.

Resignations

Full members 21, *Family members* 3, *Junior member* 1, *Institutional member* 1.

Struck off for non-payment of subscriptions

Full members 16, *Family members* 2, *Junior members* 3.

Members 'lost' without addresses

Full members 4.

Meetings

There were six Ordinary meetings and the Annual General Meeting held in the Demonstration Room of the British Museum (Natural History). The One Thousandth Meeting of the Conchological Society was a joint meeting with the Yorkshire Conchological Society held at the Leeds City Museum. A Marine Workshop was held at Mrs. Light's house in Godalming.

Publications

Two parts of the *Journal of Conchology* were issued (Volume 32, parts 5 and 6). Four issues of the *Conchologists' Newsletter* were printed and issued with the Annual Programme Card of events. A list of amendments to the membership list was issued in May 1987.

Subscribers

The total number of subscribers is 135 who took out a total of 145 subscriptions to the *Journal*. There were 13 subscribers to the *Conchologists' Newsletters* and *Papers for Students*.

Field Meetings

Six field meetings were held during 1987: 24th May, Yorkshire; 13th June, Pevensey, East Sussex; 27th–28th June, Weymouth, Dorset; 26th July, Herne Bay, Kent; 6th October, Chichester, West Sussex; 24th October, Gloucestershire. Thanks are due to the following for

leading these meetings: Dr. Coles, Mr. Goodchild, Mrs. Light, Mr. Long, Mr. Norris, Mr. Palmer and Dr. Rundle.

MARY B. SEDDON
Hon. Secretary

RECORDER'S REPORT: MARINE MOLLUSCA

The discovery of a thriving colony of a mollusc new to the British fauna is of particular interest; it is the prosobranch *Caecum armoricum* De Folin from the Fleet lagoon in Dorset (S16 Portland) (*Conchologist's Newsletter* **103**, p. 66). Previous records are from the Atlantic coast of Portugal, Spain and France, but I know of no reports of living animals or their habitat.

Onoba aculeus (Gould) was until recently regarded as a northern species with southern limits in Scotland and Denmark, but in 1983, Biekart (*Basteria* **47**, p. 54) reported it from localities along the European Atlantic coast as far south as Galicia, Spain. In 1987, R. A. Cadwalladr (pers. comm.) found it living in a closed lagoon in Suffolk (S13 Thames). This prompted a re-examination of the *Onoba* 'semicostata' population living in the Fleet, Dorset (S16 Portland); *O. aculeus* proved to be present living alongside the common, widespread and very variable *O. semicostata* (Montagu) (Seaward, *Proc. Dorset NHAS*, in press). Separation of these two species is difficult, requiring a careful examination of several characters, and many specimens will be indistinguishable (Fretter and Graham (1978) Prosobranch Molluscs of Britain and Denmark, *Suppl. 6, J. moll. Stud.* p. 166, and Dr. V. Fretter (pers. comm.).

Considerable advances in recording have again been made around Ireland in the course of investigations by University College, Galway in S39 Nympe Bank (Keegan *et al*, *Proc. R. Ir. Acad.* **87B** (1987), pp. 1–14 and *Ir. Nat. J.* **22** (1988), pp. 373–385), and by Nunn and Picton in S36 Galway, and Nunn and Smith in S29a Antrim and S33 North Donegal (*Conchologist's Newsletter*, **101**, pp. 13–15 and **102**, pp. 33–39). Nunn and Picton report the find of a single valve of *Pseudopythina setosa* (Dunker), new to the British-and-Irish fauna.

In S34 Donegal Bay, Mrs. H. Ross (pers. comm.) found an interesting crevice community, adding or updating several species among which the following, all live, are of note: *Alvania cancellata* (da Costa), the first live Irish record. *Gastrochaena dubia* (Pennant); this extends northward the range of this southern species, otherwise only known from S36 Galway and from the western Channel in the *Sea Area Atlas* area. *Notirus irus* (L.); updating old records of another southern species also at its northern limit. A few shells from further north in Ireland and West Scotland may be subfossil.

D. R. SEAWARD

RECORDER'S REPORT: NON-MARINE MOLLUSCA

The following new vice-comital records have been verified since the last Report (*J. Conch., Lond.* **32**, p. 380). All date from 1987–88, unless stated otherwise.

Devon South (3): *Theodoxus fluviatilis*, R. Axe, Whitford (30/2694), D. E. Bolton; *Andonta cygnea*, Great Western Canal, Tiverton (21/9812), M. R. Hughes, 1986.

Middlesex (21): *Arion flagellus*, Islington (51/3284; garden), Jane Reynolds.

Suffolk West (26): *Limax cinereoniger*, Wolves Wood, Aldham (62/0543), I. J. Killeen.

Bedford (30): *Arion lusitanicus*, Luton (52/0725), Mrs E. B. Rands.

PROCEEDINGS

- Gloucester East (33): *Arion flagellus*, Slad (32/8708), D. C. Long.
 Carmarthen (44): *Trichia plebeia*, Dryslwyn Castle (22/5520), A. O. Chater.
 Montgomery (47): *Pyramidula rupestris*, Guilsfield (33/2512); *Ceciloides acicula*, Welshpool (33/2105), both R. Wistow.
 Merioneth (48): *Milax sowerbyi*, Llanbedr (23/6028), A. O. Chater.
 York North-east (62): *Limax tenellus*, Bridestones, Lockton (44/8791), A. Norris.
 Westmorland (69): *Arion flagellus*, Ambleside (35/3603), I. J. Killeen.
 Edinburgh (83): *Boettgerilla pallens*, Glencorse (36/2462), A. T. Sumner.
 Stirling (86): *Leiostyla anglica*, *Zenobiella subrufescens*, Ballagan Glen, Strathblane (26/5780), Mrs D. K. Marriott, 1986.
 Westernness (97): *Vertigo modesta*, Ben Alder range, Grampians (27/47), R. W. Marriott.
 Ross East (106): *Gyraulus laevis*, Loch Achnacloich (28/6673); *Sphaerium corneum*, *Pisidium hibernicum*, Loch Achanalt (28/2761), all Sandra Hogg.
 Orkney (111): *Helicella itala*, Bay of Skail, Mainland (HY2319), B. Colville.
 Roscommon (H25): *Boettgerilla pallens*, Carrick-on-Shannon (12/9399); *Zenobiella subrufescens*, Roscommon (12/8862), both J. Hutchinson.

The outstanding discovery of 1987 was of *Vertigo modesta* (syn., *V. arctica*), a species not hitherto reported from the British Isles. The site in Inverness-shire lies at nearly 1,000 m O.D. and the vegetation is of subarctic type. An account by Richard and Dorothy Marriott will be found on p. 51. The precise grid reference is not published as the habitat is fragile and in need of protection.

Two other records worthy of note are of *Limax cinereoniger* in Suffolk and of *Limax tenellus* in North-east Yorkshire. Both finds considerably extend the known ranges of these old woodland slugs within the British Isles.

M. P. KERNEY

COMMUNICATIONS

NEOLEPTON SYKESI IN GUERNSEY

The small bivalve *Neolepton* (= *Arculus*) *sykesi* Chaster, 1895 appears to be scarce in British waters, its reported sightings having been few since Chaster's papers of 1895 (*Ann. and Mag. Nat. Hist.* (1895) p. 248 and *J. Malac.* 4 (1895) p. 58). Chaster reports it (as *Lepton sykesi*) from the Channel Islands, from Mounts Bay, Cornwall and from Dogs' Bay, Connemara. Marshall (*J. Malac.* 4 (1895) p. 37) claims to have had 'a live specimen and half-a-dozen valves' off the east coast of Guernsey in 1893. In 1897, Marshall (*J. Conch. Lond.* 8 (1897) p. 346) repeats previous reports and adds that it has been found in Killala Bay; and in 1914 (*J. Conch. Lond.* 14 (1914) p. 182) he makes further reference to its having been found off Scariff, S. W. Ireland, in 40 fathoms.

More recently, in 1973, it was reported (live) as *Arculus sykesi* in a list of new additions to the species list of the molluscan fauna of the region of Roscoff, Brittany (Babio, *Trav. Stat. Biol. Roscoff* XX (1973) (31) pp. 1–4).

In June, 1987 I took a sample of shell sand at Vazon Bay, Guernsey and subsequently found in it three valves of *N. sykesi* among more numerous valves (both separate and paired) of *N. sulcatulum* (Jeffreys) which it resembles somewhat externally. It was only while I was making up a growth series of valves of *N. sulcatulum* that it became clear, from details of the hinge, that three valves were not of this species but of *N. sykesi*.

I am grateful to Dr. J. J. van Aartsen for his help in identifying the valves; Dr. van Aartsen also reports having specimens from Hendaye (Pyrenées-Atlantiques, France) and from Sidi Ferruch (Algeria). I am also greatly indebted to Mr. Dennis R. Seaward for his help with bibliographical references mentioned in this Communication.

J. E. PHORSON

5 Fellside Gardens, Belmont Durham, DH1 1AB

(Received, 17th January, 1988)

A PEARL FROM THE WEST RUNTON FRESHWATER BED (CROMERIAN)

Freshwater mussels have long been known to produce pearls that encapsulate parasites or extraneous sand-grains trapped between the mantle of the shell. Pearl production in freshwater mussels is chiefly associated with species of the family Margaritiferidae and although known to occur in other families, its incidence there appears to be less frequent. Two types of pearl are distinguished. Pearly protuberances or blister pearls are not uncommon in freshwater bivalves including forms as small as *Pisidium* (e.g. Kuiper, J. G. J., *Corresp Blad ned. Malac. Veren.* No 194 (1980), pp. 1019–1020). Detached, or true, pearls appear to be somewhat rarer.

This note records the discovery of one of the latter in the West Runton Freshwater Bed in Norfolk. It is irregularly spherical, has a dull iridescent lustre and a diameter of 3.3 mm. It was recovered from a bulk sample of bed f of West (1980, *The pre-glacial Pleistocene of the Norfolk and Suffolk coasts*, Cambridge University Press) at a point 170–173 m east of Woman Hithe (TG 187432). It therefore comes from the stratotype of the Cromerian interglacial (early Middle Pleistocene). Three species of large mussel (*Anodonta cygnea*, *A. anatina* and *Unio pictorum*) are known from this deposit (Sparks in West, R. B. (1980) *op cit*) and so it is uncertain which of these three species was responsible.

There are numerous reports of fossil pearls in the literature but most refer to their occurrence in marine deposits of Mesozoic or Tertiary age (e.g. Newton, R. B., *Proc. malac. Soc. Lond.* 8 (1908) pp. 128–139; Jackson, J. W., *Proc. malac. Soc. Lond.* 8 (1909) pp. 318–320; Jackson, J. F., *Proc. Isle Wight nat. Hist. Soc.* 1 (1926) p. 466; Russel, R. D., *Amer. J. Sci.* 18 (1929) pp. 416–428; Haas, F., *Natur und Museum* 61 (1931) p. 120; Backmayer, F. & Binder, H., *Ann. Naturhist. Mus. Wien* 71 (1967) pp. 1–12. Reports of fossil pearls from freshwater deposits are comparatively rare and although there are several from the Neogene of continental Europe (e.g. Stiva, A., *Corresp Blad ned. Malac. Veren.* No 196 (1980) p. 1070; Szónoky, M., *Soosiana* 8 (1980) pp. 17–20; Krolopp, E., *Soosiana* 8 (1980) pp. 21–23) I can trace no other record from the British Pleistocene.

I thank John Clayden whose industrious sieving produced this interesting fossil which is now lodged in the University Museum of Zoology, Cambridge.

R. C. PREECE

Department of Zoology, Downing Street, Cambridge CB2 3EJ

(Received, 10th February, 1988)

A LIVING SPECIMEN OF *THAIS* (*STRAMONITA*) *HAEMASTOMA* L. FOUND ON BEACH DEBRIS IN SOUTH WALES, U.K.

In January 1988 Mr R. J. Southcott sent a gastropod to the National Museum of Wales for identification. The specimen had been found still attached to a polystyrene float on the beach at Crymlyn Burrows, Neath, South Wales. The animal was intact, Mr Southcott noting that the operculum was horny, attached to a yellowish foot. Also on the float were a number of goose barnacles which Mr Southcott regarded as *Lepas anatinus* although this was not confirmed.

The shell is that of *Thais* (*Stramonita*) *haemastoma* Linnaeus 1767, (NMW.2.1988.010) and is the first record of this species from British Waters. *T. (S.) haemastoma* has a wide distribution from Angola to Brittany in the West Atlantic and from Uruguay to Bermuda in the East Atlantic. It is a very variable species (Clench, W. J. Johnsonia **2** (1947) pp. 61–91.) and it has not been possible to associate the above specimen with any single population. It is probable that this specimen was drifting on Gulf Stream currents and may therefore have come from the Eastern Atlantic. This is not the first time that *T. (S.) haemastoma* has been recorded from drifting debris, Clench (1947) also noted a specimen on a log 300 miles N.W. of Madeira.

Although occurring as far north as Brittany *T. (S.) haemastoma* has never established itself on British coasts. This record establishes the possibility of dispersal to the U.K. but clearly other factors inhibit colonization.

It is not suggested that *T. (S.) haemastoma* be added to the British list as its presence is obviously accidental. It is however notable that such dispersal mechanisms so often mentioned do actually occur.

P. GRAHAM OLIVER

National Museum of Wales, Cathays Park, Cardiff, CF1 3NP

(Received, 21st February, 1988)

CYMATIUM MURICINUM PREDATES CULTIVATED CRASSOSTREA RHIZOPHORAE

The knobby triton *Cymatium muricinum* Röding killed and ate 88.9% of cultivated mangrove oysters, *Crassostrea rhizophorae* (Guilding), within one day in a series of trials. After four days 94.4% of the oysters had succumbed. None of the control oysters died. Experiments were conducted with one oyster and one triton in plastic dishes suspended in the sea at an oyster culture site in Port Morant, St. Thomas, Jamaica (Lat. 17°35'N; Long. 76°35'W). Oysters and tritons were collected from commercial rafts. There were 18 replicate experimental trials with an equal number of controls. Mean oyster shell height was 34.6 mm (SD = 6.13; N = 36) and mean triton shell length was 34.6 mm (SD = 5.36; N = 18). There was no significant difference in shell height between control and experimental oysters.

C. muricinum has been recorded as a predator of commercially grown tridacnid clams in Micronesia (Perron *et al.*, *Aquaculture* (1985) **48**, p. 211) but this is the first observation of knobby tritons attacking oysters. *C. muricinum* appears less frequently than the equally voracious *C. pileare* L. on commercial rafts in Jamaica (Littlewood, *J. Moll. Stud.*, in review), but its relatively high rate of predation may allow it to become a serious pest if left uncontrolled. Control may best be achieved by manual removal.

D. TIMOTHY J. LITTLEWOOD

Oysterseed Cooperative Project, Department of Zoology, University of The West Indies, Mona, Kingston 7, Jamaica, W.I.

(Received, 15th April, 1988)

(Present address, Shellfish Research Laboratory, New Jersey Agricultural Experiment Station, Cook College, Rutgers University, Port Norris, New Jersey, 08349, USA)

JOURNAL OF CONCHOLOGY, VOL. 33, NO. 2
INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

Opinions published in the Bulletin of Zoological Nomenclature

Bulletin of Zoological Nomenclature, Volume 44 (1987) Parts 3 and 4

- Opinion 1455 *Clausilia* Draparnaud, 1805 (Mollusca, Gastropoda): *Pupa rugosa* Draparnaud, 1801 designated as type species
Opinion 1456 *Ammonites* (currently *Euaspidoceras*) *perarmatus*. J. Sowerby, June 1822 (Cephalopoda, Ammonoidea): conserved despite the senior primary homonym *Ammonites* (currently *Peronoceras*) *perarmatus* Young & Bird, [May] 1822

The following Opinions were published on 25 March 1988 in Vol. 45, Part 1 of the *Bulletin of Zoological Nomenclature*.

- Opinion 1470 SINUITIDAE Dall, 1913, MACLURITIDAE Carpenter, 1861 and EUOMPHALIDAE de Koninck, 1881 (Gastropoda, Archaeogastropoda): conserved
Opinion 1471 *Aplysia* (originally *Laplysia*) *viridis* Montagu, 1804 (Mollusca, Gastropoda): specific name conserved

The following Opinions and a Direction were published on 24 June 1988 in Vol. 45, Part 2 of the *Bulletin of Zoological Nomenclature*:

- Opinion 1487 *Megalonaias* Utterback, 1915 (Mollusca, Bivalvia): conserved
Direction 123 The Sowerbys' *Mineral Conchology of Great Britain*: Official List entry authorized

INSTRUCTIONS TO AUTHORS

Manuscripts should be sent to:— **Dr D. T. Holyoak, School of Geography and Geology, The College of St. Paul and St. Mary, The Park, Cheltenham, Gloucester, GL50 2RH.**

PAPERS Two copies of text and illustrations should be submitted; one set of illustrations must be good quality originals. Authors should refer to recent copies of the *Journal* for a guide to format. Authors are reminded of the high cost of printing and therefore are expected to write concisely and to make maximum use of page size when designing art-work and tables.

COMMUNICATIONS These are intended to be short notes of an original nature which do not merit the treatment of a full paper. *Communications* must not contain any figures, tables or plates and should conform in style to that of recent issues of the *Journal*.

Journal of Conchology

Vol. 33, Part 2, December 1988

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CONCHOLOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND

Annual subscriptions (for rates see inside front cover) fall due on 1st January. Members whose current subscriptions are unpaid will not receive any of the Society's publications. Please ensure that remittances cover the total amount due. Receipts will only be issued on request, accompanied by a stamped addressed envelope (overseas Members may add 10p to the amount sent). Cheques, etc. should be made payable to the *Conchological Society of Great Britain and Ireland* and not to any individual officer by name.

Members are requested to notify the Hon. Secretary promptly of any change of address.

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Part 5

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CONCHOLOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND

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NOTICE

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Overseas members are reminded that all monies due to the Society are payable in sterling.

CILIELLOPSIS OGLASAE, A NEW HYGROMIID FROM MONTECRISTO ISLAND (TUSCAN ARCHIPELAGO, ITALY) (PULMONATA: HELICOIDEA)¹

FOLCO GIUSTI² AND GIUSEPPE MANGANELLI²

(Accepted for publication, 21st October 1989)

Abstract: A new genus, *Ciliellopsis*, is described for a new species, *C. oglasae*, living on Montecristo Island (Tuscan Archipelago, Italy). Hypotheses on the relationships between the new genus and other genera having similar genital duct structure are discussed. This finding stresses the faunistic importance of Montecristo I., which, recently, has been declared an Integral Natural Reserve of European Interest.

INTRODUCTION

Insular equilibrium theory studies culminating in the analytical comparison of the malacofauna of the Tuscan and Aeolian Archipelagos (Italy) (Piantelli *et al.* 1990) made it necessary to verify and amplify the preexisting data on terrestrial gastropods (Giusti 1968a, 1968b, 1970, 1976, 1977).

During this investigation two specimens (only one in spirit) collected on the island of Montecristo (Tuscan Archipelago) came to our attention. The small, hairy shell likened them to a new taxon recently described by ourselves (Giusti & Manganelli 1989b) known to live on La Praiola (an islet near the island of Capraia, Tuscan Archipelago, Italy) and in Sardinia.

The first spirit specimen and others collected later were dissected and their genital duct structure was found to be so peculiar as to represent a new species of a yet undescribed genus.

CILIELLOPSIS NEW GENUS

Description

Shell: small, pilose, brown in colour, very low conical above, convex below. Spire of ca. 4 slowly and regularly increasing whorls separated by deep sutures; last whorl slightly angled at the periphery. Umbilicus open, deep and wide ca. 1/5–1/6 of the maximum shell diameter. Mouth oval or roundish; peristome not thickened, slightly reflexed only at its lower margin.

External surface of the protoconch marked by raised and undulating growth lines, longitudinal grooves and impressions of hair roots. Periostracal surface of the teleoconch patterned by close transverse growth lines, rows of short hairs and minute spiral crests.

Genital duct: characterized by a very reduced vagina, much shorter than the free oviduct and

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²Dipartimento di Biologia Evolutiva, Via Mattioli 4; I-53100 Siena, Italy.

sometimes practically absent, without any trace of dart-sac complex or digitiform glands. The ductus of the bursa copulatrix is twice the length of the free oviduct and has a flared initial portion; the bursa copulatrix (i.e. gametolytic gland) is sac-like, more or less elongated, adheres to the ovispermiduct surface and is not inserted in the diaphragm.

The penis (i.e. the portion of the penial complex from the insertion of the penial retractor to the genital atrium) is much longer than the epiphallus (i.e. the portion of the penial complex from the point where the vas deferens ends and the penial flagellum arises to the point where the penial retractor is inserted). The penis is enveloped by a thin muscular sheath and its external walls contain glandular tissue. The penial flagellum is very short and has the same diameter as the vas deferens. A very reduced papilla is present inside the penis. The papilla embraces the opening of the epiphallus into the penis. Such a papilla has a lobate rim and one of the lobes is sometimes continuous with a wide pleat in the penial wall. The penial papilla is a stable structure which can nevertheless be regarded as an extroflexion of the epiphallus into the penis. Its inside shows rows of papillae which are continuous with those in the epiphallus. The penial nerve apparently originates from the right cerebral ganglion. The right ommatophore retractor passes between the penis and the vagina.

Derivatio nominis

The name *Ciliellopsis* is intended to stress the apparent (mainly anatomical) likeness between the new genus and *Ciliella*.

Type species

Ciliellopsis oglasae n. sp. (Figs. 1A–E, 2A–C, 3A–C,E; Pl. 27, figs. A–D; Pl. 28, figs. A–D; Pl. 29, figs. A–D)

Helicella (Xerotricha) conspurcata, – Giusti, 1968a. *Atti Soc. toscana Sci. nat. Mem.*, (B), **75**: 250–251 (partim, non Draparnaud, 1801).

Helicella (Xerotricha) conspurcata, – Giusti, 1977. *Atti Soc. ital. Sci. nat. Mus. civ. Stor. nat. Milano*, **118**: 283 (partim, non Draparnaud, 1801).

Description

Shell (Pl. 27, figs. A–D; Pl. 28, figs. A–D): small, pilose, brown in colour, convex, rounded below, with a very slightly raised spire of $3\frac{1}{2}$ –4 regularly increasing whorls separated by deep sutures. Last whorl gently angled at the periphery. Umbilicus open, deep and wide $\frac{1}{5}$ – $\frac{1}{6}$ of the maximum shell diameter. Mouth oblique, oval or rounded. Peristome not thickened, slightly reflexed at its lower margin.

External surface of the protoconch marked by a close series of small grooves, with raised undulating and frequently fragmented growth lines and with small hairs or impressions of hair roots. Periostracal surface of the teleoconch patterned by close transverse growth lines, rows of short hairs and minute longitudinal crests.

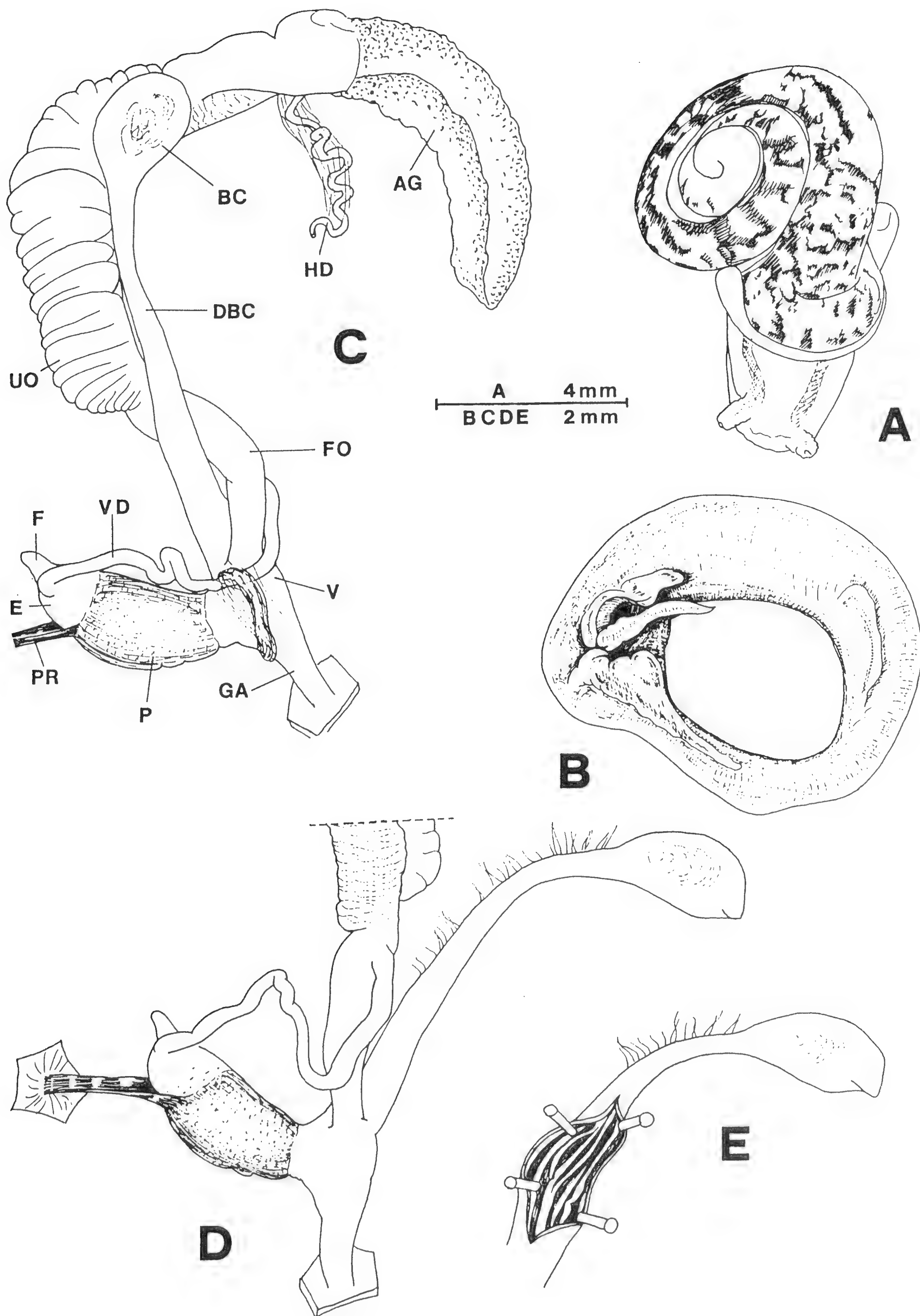
Dimensions. Max. diam.: 5.3–6 mm; height: 2.8–3.4 mm.

Genital duct (Figs. 1C–E, 2A–C, 3A–C,E): The first hermaphrodite duct arises from a plurilobate gonad and ends in the ‘talon’ (i.e. fertilization chamber + seminal receptacle

Fig. 1. *Ciliellopsis oglasae* n. sp. from Montecristo Island (Tuscan Archipelago, Italy).

A: body. B: the mantle collar. C–D: two views of a genital duct. E: the inner structure of the duct of the bursa copulatrix.

Explanations of the symbols used in Figs. 1–3: **AG** albumen gland, **BC** bursa copulatrix (gametolytic gland), **DBC** duct of the bursa copulatrix, **E** epiphallus, **F** flagellum, **FO** free oviduct, **G** penial papilla (glans), **GA** genital atrium, **HD** hermaphrodite duct, **P** penis, **PR** penial retractor muscle, **PS** penial sheath, **PW** penial walls, **RCG** right cerebral ganglion, **T** talon, **UO** uterine portion of the ovispermiduct, **V** vagina, **VD** vas deferens.



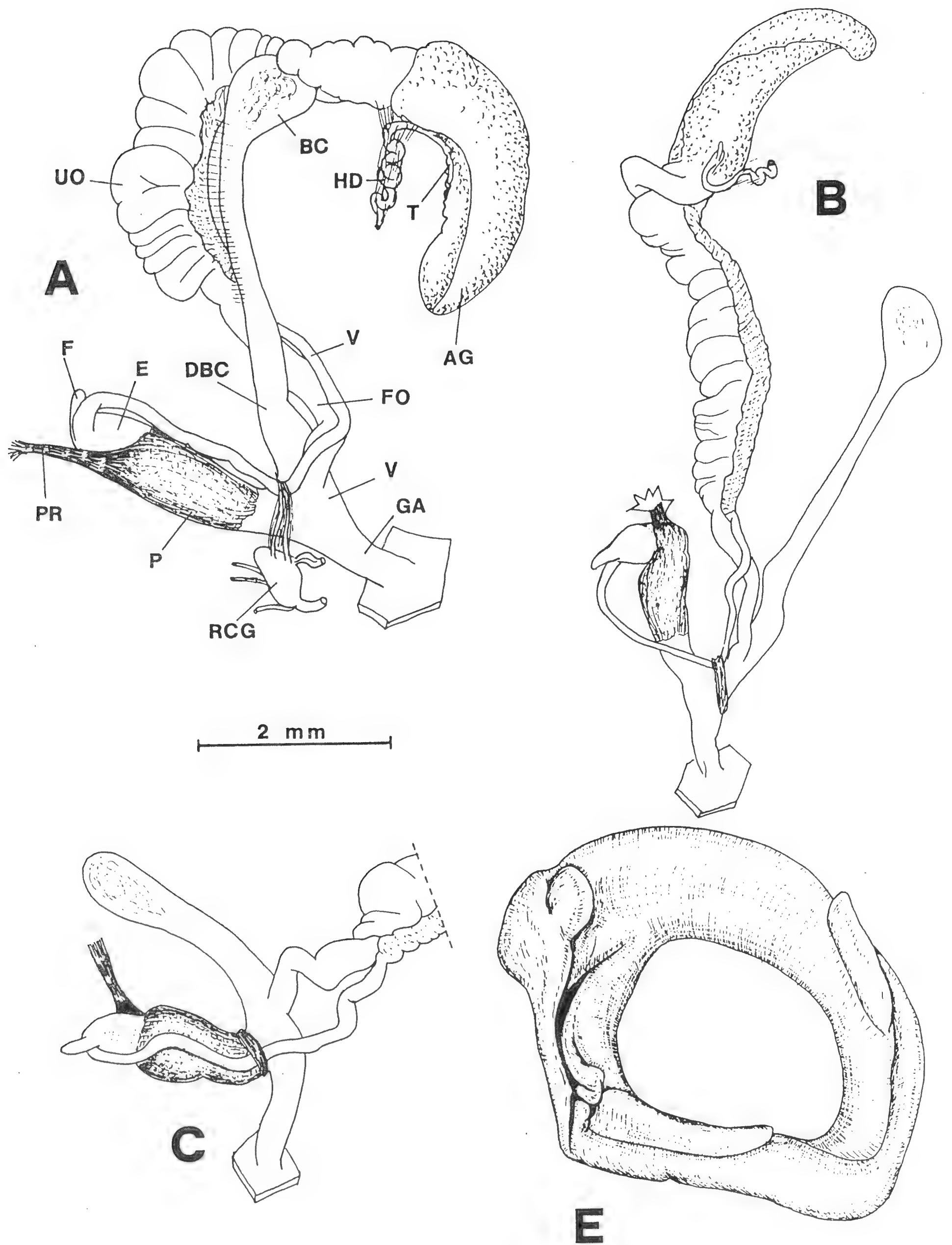


Fig. 2. Genital ducts (A–C) of *Ciliellopsis oglasae* n. sp. from Montecristo Island (Tuscan Archipelago, Italy) and mantle collar (E) of *Ciliella ciliata* (Studer) from Col di Tenda (Piedmont, Italy) M. Bodon Leg. 16.6.82. (Symbols as in Fig. 1).

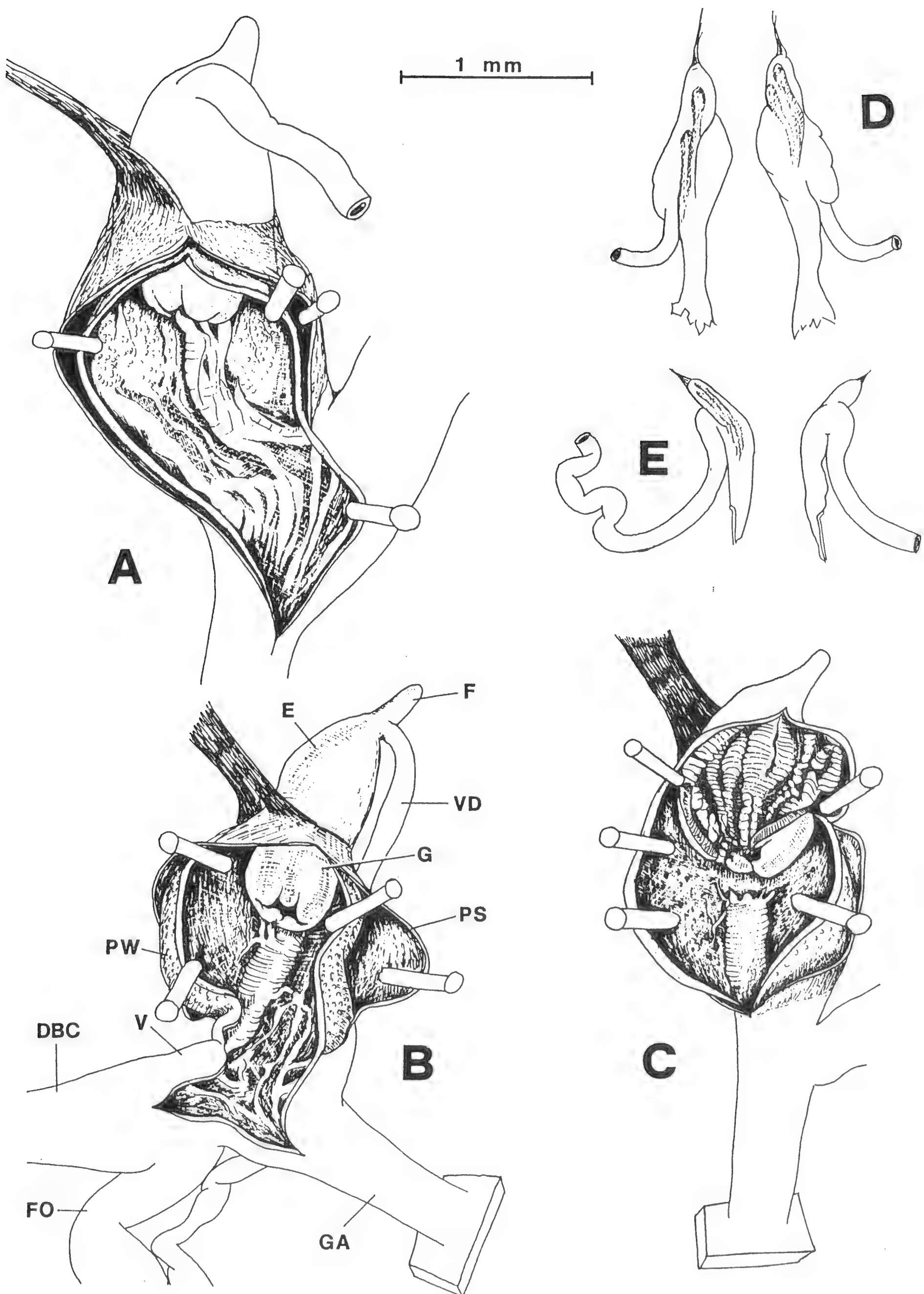


Fig. 3. The inner structure of the penis and epiphallus (A–C) and talon (E) of *Ciliellopsis oglasae* n. sp. from Montecristo Island (Tuscan Archipelago, Italy) and the talon (D) of *Ciliella ciliata* (Studer) from Col di Tenda (Piedmont, Italy) M. Bodon leg. 16.6.82. (Symbols as in Fig. 1).

complex) which lies on the surface of the inner side of a large albumen gland. The talon is very small and has a wide latero-basal fecundation chamber which embraces the middle portion of the receptacle portion which is apically elongated. The ovispermiduct is wide, plurilobate and consists of prostatic and uterine portions. The prostatic portion continues anteriorly into the vas deferens and the proximal portion of the penial complex. Close to the end of the vas deferens a very short penial flagellum arises. The latter is as wide as the vas deferens and shorter than the epiphallus. The epiphallus is very short ($1/3$ the length of the penis). The penis lacks a proximal portion (i.e. the part extending from where the penial retractor ends to where the base of the papilla is inserted), is enveloped by a thin muscular sheath which begins close to the point of insertion of the penial retractor and ends near the genital atrium. The external walls of the penis contain glandular tissue. The penial retractor muscle is usually short or very short. Inside the penis a small penial papilla embraces the epiphallus opening into the penis. This penial papilla has a large apical opening with a lobate rim. The inner surface of the penial wall is marked by a few irregularly disposed plicae and a large pleat which arises from or near one of the lobes of the penial papilla rim. The genital atrium is long. The uterine portion of the ovispermiduct continues anteriorly into a long uterine canal (i.e. free oviduct) which enters the vagina level with the insertion of the penis. The ductus of the bursa copulatrix is long and flared in its initial portion. The bursa copulatrix (i.e. gametolytic gland) is oval-elongate in shape. The vagina is very short and frequently so reduced as to appear lacking.

The radula (Pl. 29, figs. A–D) consists of many rows of teeth each according to the formula $20-22 + C + 20-22$. The central tooth has a wide basal plate with raised pointed upper vertices. The body of the tooth has an apex with a very large mesocone and two small ectocones. The first lateral teeth also have a wide basal plate, but a large pointed mesocone and a small pointed ectocone half of the mesocone length. The inner side of the mesocone is frequently milled and shows a slight protruberance at half its length. The internal and external sides of the ectocone are also milled. Moving laterally, the teeth maintain the same shape but become progressively smaller with more slender cusps and reduced basal plates. The last marginal teeth have the mesocone apex with two points and an ectocone split into 2–6 points.

Mantle collar (Fig. 1B) with small right and left dorsal lobes, small thin left lateral lobe, long thin triangular subpneumostomal lobe, long triangular (wider near the anus) right lateral lobe.

Locus typicus

Cala Maestra, Montecristo Island (Tuscan Archipelago, Italy).

Typical series

Holotype (shell) and 53 paratypes from Cala Maestra, Montecristo Island (Tuscan Archipelago, Italy), F. Giusti leg., 2.V.67, 4.XI.75; F. Giusti, G. Manganelli & F. Frati leg. 8.V.88 (40 shells plus 15 spirit specimens 4 of which dissected). One paratype (shell) in the collections respectively of the Senckenberg Museum Frankfurt (SMF 307501) and of Göteborgs Naturhistoriska Museum (GNM K.G. 88–17644). Holotype and all the other paratypes in Giusti coll. (Dip. Biol. Evolutiva, Univ, Siena, Italy).

Derivatio nominis

The name of the new species is derived from Oglasa, the ancient name of the island of Montecristo.

DISCUSSION

The new genus resembles many taxa living on the Italian peninsula and islands, by virtue of its small hairy shell.

Xerotricha and *Microxeromagna* can be easily distinguished by the presence of white flecks on the teleoconch whorls and discontinuous spiral bands of variable colour (whitish or brown) (see Giusti & Manganelli 1989b, Pls. 1–3). The above mentioned genera are also clearly distinguishable by their genital duct structures which, unlike the new genus, have dart-sac complex and tufts of digitiform glands annexed to the vagina (see Hausdorf 1988, Manganelli & Giusti 1988, for *Xerotricha*; Clerx & Gittenberger 1977, Hausdorf 1988, Manganelli & Giusti 1988, for *Microxeromagna*). The new genus cannot have originated recently from such taxa because of the many other anatomical peculiarities which characterize it: well developed penial sheath, absence of glandular atrial portion, structure of the penial papilla, reduced penial flagellum, right ommatophore retractor passing between penis and vagina. *Ciliellopsis* is closer both in shell and anatomy to a group of genera recently studied and/or described by ourselves from other Tyrrhenian islands: *Cyrnotheba* from Corsica (Giusti & Manganelli 1987), *Schileykiella* from Sicily (Manganelli *et al.*, 1989) and *Tyrrheniella* from Sardinia and the Tuscan Archipelago (Giusti & Manganelli 1989b).

Cyrnotheba has a larger shell (max diam.: 12–15.6 mm) with a completely different periostracal microsculpture (Giusti & Manganelli 1987, pp. 136–137, Pl. 9, figs. A–E) both on the protoconch (spiral rows of small tubercles) and on the teleoconch (transverse rows of nail-like scales). Although anatomically similar by virtue of the total absence of structures annexed to the vagina (dart-sac complex and digitiform glands), *Cyrnotheba* is clearly different in its very long vagina, very long or long flagellum, long epiphallus, penial walls without glandular tissue and long cylindrical penial papilla with a small subapical opening (Giusti & Manganelli 1987, pp. 136–137, Figs. 4–5).

Schileykiella is more similar. Its hairy shell is almost the same size (max. diam.: 6.5–8 mm) and has a similar microsculpture on the teleoconch whorls (longitudinal rows of thin crests) (see Manganelli *et al.* 1989, Pl. 12, figs. A–D, Pl. 13, figs. A–D) but a different microsculpture of the protoconch whorls (without fragmented growth lines and with deep pits). The hairs are more numerous and noticeably longer. Anatomically, *Schileykiella* differs, having a longer vagina, longer epiphallus, longer slender penial flagellum, absence of a true penial papilla possibly replaced by a knob arising on the inner surface of the penis wall.

Tyrrheniella is almost indistinguishable in its shell characters from the new genus; nevertheless its protoconch is without wrinkled or fragmented growth lines and its teleoconch has a periostracal surface with a close series of longitudinal grooves without any trace of longitudinal crests. Anatomically, *Tyrrheniella* differs from the new genus by virtue of the constant presence of an evident, albeit short, vagina, a proximal penis, a longer epiphallus and penial flagellum, a usually shorter canal of the bursa copulatrix, a series of pleats (instead of rows of papillae) on the inner surface of the epiphallus and a small knob-like structure arising at the beginning of the wide pleat on the internal surface of the penial wall (Giusti & Manganelli 1989b, Fig. 1).

It is extremely interesting to compare the new genus and *Ciliella*. Although characterized by a larger shell of noticeably different shape and microsculpture (Manganelli *et al.* 1989, Pl. 14, figs. A–E), *Ciliella* shows a strong anatomical likeness with *Ciliellopsis*. It has, in fact, a similarly structured penial complex (lacking the proximal penis) and a penial sheath originating near the point of insertion of the penial retractor. Moreover it has a short epiphallus, a short penial flagellum which has initially the same diameter as the epiphallus, rows of papillae and some pleats on the inner surface of the flagellum and of the epiphallus, very reduced vagina, a fairly similar mantle collar, right ommatophore retractor passing between penis and vagina and penial nerve apparently starting from the right cerebral

ganglion. *Ciliella* differs mainly in the shape of the penial papilla (tongue-like) and the absence of a large pleat on the inner surface of the penis wall (Manganelli *et al.* 1989, Fig. 6).

The arguments utilized to differentiate *Schileykiella* (see Manganelli *et al.* 1989) from the other taxa of the genus group of the Hygromiidae (sensu Schileyko 1972, 1978b), apparently similar to the new genus by virtue of the absence of the vaginal accessory structures (*Gasuliella*, *Metafruticicola*, *Cretigena*, *Caucasocressa*, *Szentgalia*, *Ashfordia*), apply equally to *Ciliellopsis*.

From the above the difficulty we had in deciding how to classify the new Montecristo species is sufficiently evident. The solution of creating a new genus has been carefully considered. As stressed by us elsewhere (Giusti & Manganelli 1987, 1989a, 1989b, Manganelli & Giusti 1988, Manganelli *et al.* 1989), when a hygromiid has a genital duct lacking any kind of vaginal accessory structures its position in the classification scheme becomes necessarily a matter of opinion, or at best based on characters the true diagnostic value of which has yet to be determined (i.e. penial complex structure, position and structure of other anatomical structures, shell shape and periostracal microsculpture). Consequently in such cases, and in the present case, it is impossible to get enough data to reveal if a morphological likeness is evidence of a true relationship or the consequence of occasional convergence.

Disregarding both the geographical contiguity (*Tyrrheniella* and *Ciliellopsis* live in the Tuscan Archipelago) and characters such as those of the shell, clearly subject to convergence, *Tyrrheniella* and *Ciliella* turn out to be very similar to *Ciliellopsis*, particularly if we rely upon anatomical features.

It appears possible that *Ciliellopsis* descended from the group to which *Tyrrheniella* belongs or directly from *Tyrrheniella* by anatomical modifications which caused it to converge with *Ciliella*. This hypothesis however implies a long period of independent evolution and makes it possible to propose *Ciliellopsis* as a separate genus.

As stated elsewhere (Giusti 1976), Montecristo (to which the new taxon is endemic) has a peculiar malacofauna suggesting that the island was colonized in very ancient times (soon after it emerged from the sea about 5 my ago), possibly from the contiguous 'calcareous complex' of the southern portion of the Tuscan Archipelago, which never entirely submerged during the Tertiary. It possibly included islands such as Giglio, Giannutri and the Argentario Promontory and was in close contact with Apennine Italy. Thus it is possible also that *Ciliella* or *Ciliella*-like forms arrived on Montecristo and later gave origin to the new taxon. While remaining basically similar in genital duct structure, *Ciliellopsis* differentiated in many details including shell structure and microsculpture so as to constitute today a valid separate genus.

Although it is not possible to decide which of the two above hypotheses is the most valid, we can recognize closer likeness of the new genus (as its name emphasizes) with *Ciliella*, at least in genital duct structure. *Ciliella* and *Ciliellopsis* share many penial complex characters (e.g. inner and outer structure of epiphallus, flagellum and penis) and a greatly reduced vagina.

As in the case of other taxa recently revised or redescribed by ourselves (Giusti & Manganelli 1989a, 1989b, Manganelli *et al.* 1989) the above problems also affect our ability to determinate the subfamilial status of the new genus. *Schileykiella*, *Tyrrheniella* and *Ciliella* (Schileyko (1972, 1978a) proposed for the latter the subfamily Ciliellinae, recently accepted by Nordsieck (1987)) cannot be included in the same subfamily because it is possible that they are similar only by convergence. It would also be absurd to create a different subfamily (as in the case of Ciliellinae) for each genus, based only on the supposition that they originated from different lineages. In such a situation we prefer to do as we have done in past papers (Giusti & Manganelli 1989a, 1989b, Manganelli *et al.* 1989), namely leave the new genus as an incertae sedis taxon of the Hygromiidae.

The new species lives under stones, fallen tree trunks or in leaf litter, particularly of damp shady sites with abundant *Ailanthus glandulosa* vegetation.

Living specimens and empty shells were very scarce; the latter are thin and poorly mineralized (Montecristo is totally granitic) and are evidently rapidly destroyed.

The new finding brings the number of land-snail species living on Montecristo to 18. *Ciliellopsis oglasae* n. sp., *Oxychilus (Alzonula) aglasicola* Giusti and *Helicodiscus riparbellii* Giusti confirm the unique nature of the malacological fauna of Montecristo, which has recently been declared an Integral Natural Reserve of European Interest.

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PLATE 27
Shells of *Ciliellopsis oglasae* n. sp. from Montecristo Island (Tuscan Archipelago, Italy). A: the holotype; B–D: three paratypes.

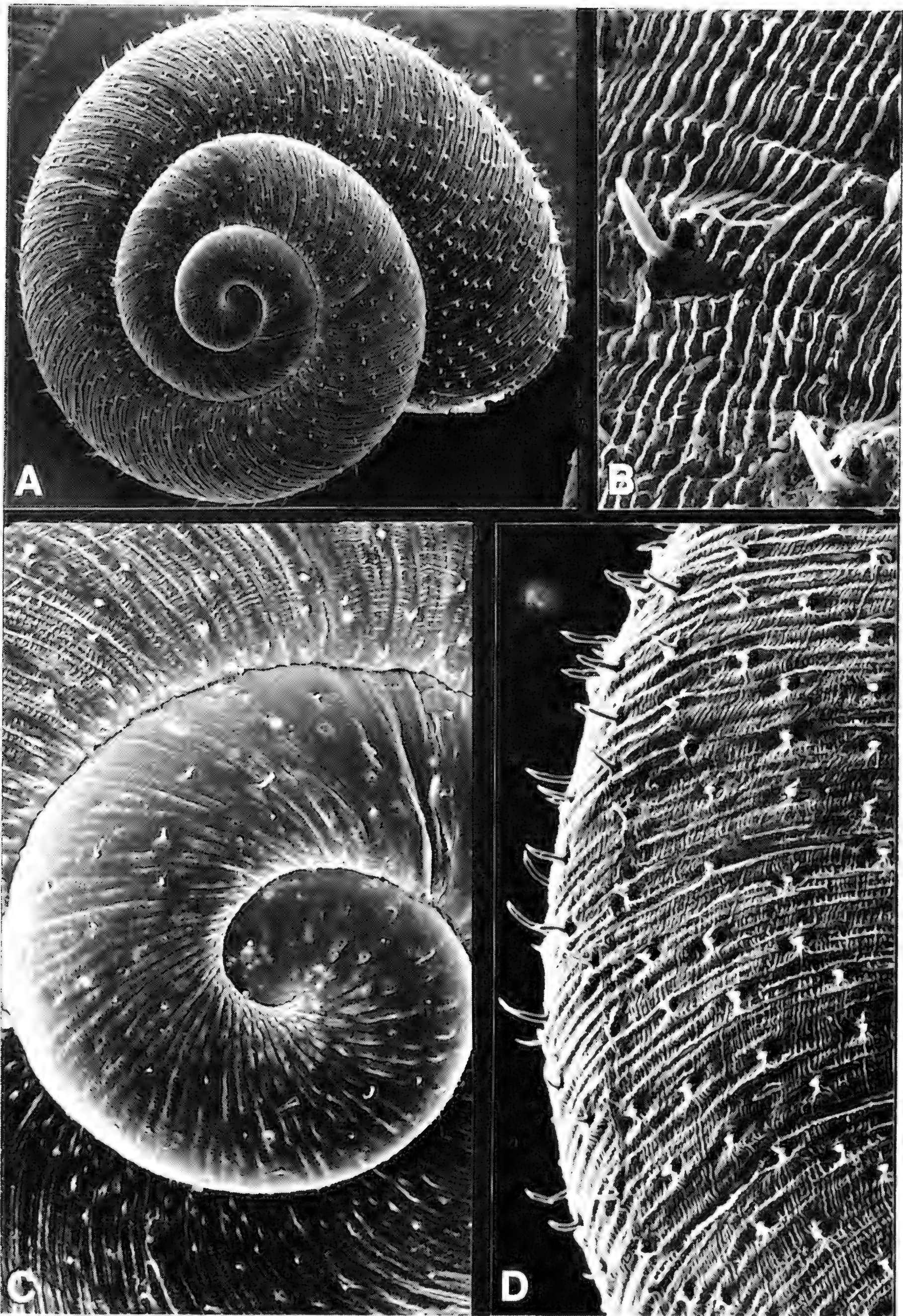


PLATE 28

The external shell surface in specimens of *Ciliellopsis oglasae* n. sp. from Montecristo Island (Tuscan Archipelago, Italy). A: a SEM view of the entire shell. B: the protoconch. C: a detail of the last whorl with hairs and longitudinal crests. D: a view of the last whorl (A $\times 16$; B $\times 60$; C $\times 200$; D $\times 50$).

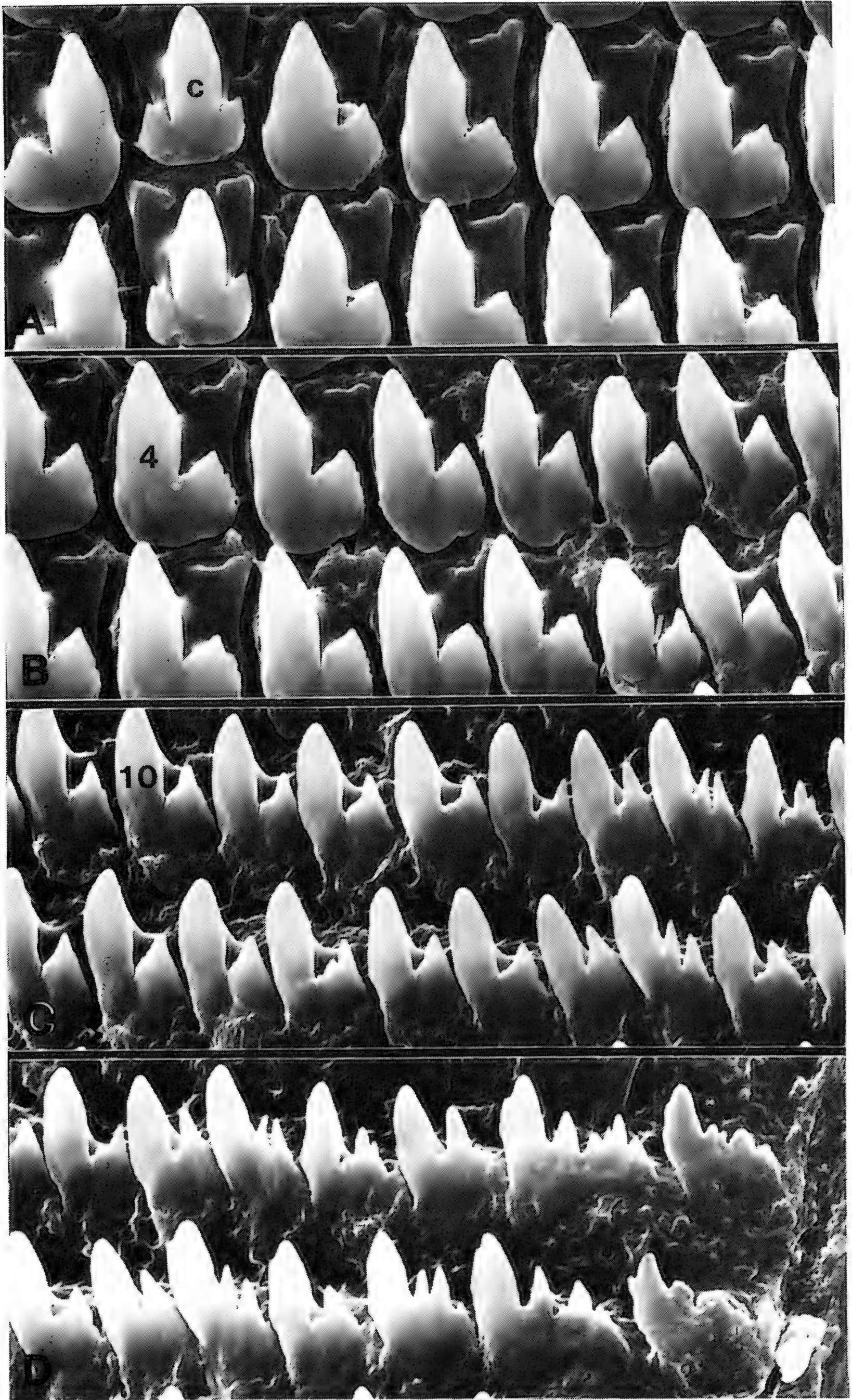


PLATE 29

The radula of a specimen of *Ciliellopsis oglasae* n. sp. from Montecristo Island (Tuscan Archipelago, Italy). A: the central tooth (c) and the first lateral teeth. B: the 4th-9th lateral teeth. C: the 9th-17th lateral teeth. D: the extreme marginal teeth (1300 \times).

A NEW SPECIES FROM THE IBERIAN
PENINSULA: *OXYCHILUS* (*ORTIZIUS*?)
BASAJAUNA N. SP. (PULMONATA: ZONITIDAE)

KEPA ALTONAGA¹

(Accepted for publication, 21st October 1989)

Abstract: *Oxychilus basajauna* n. sp. is closely related to *O. helveticus* (Blum, 1881) and *O. anjana* Altonaga, 1986 but maintains constant differences: the proximal portion of the penis has a heart-shaped appearance and the inner proximal part of the penis has 30–35 very sinuous bands. This constitutes an indication that the validity of the *Ortizius* Forcart, 1957 subgenus should be reconsidered.

INTRODUCTION

During a series of field trips (1978–1988) designed to collect information to be used in a revision of the Zonitidae of the Basque Country (Altonaga, Prieto & Ruiz de la Rosa 1988, Altonaga & Rallo 1989) we happened upon specimens superficially very similar to *Oxychilus helveticus* (Blum, 1881). Nevertheless, as soon as their genital tract was studied, it was clear that they belonged to three species: *O. helveticus*, which is very common in the Cantabrian area (Altonaga 1989b), *O. anjana* (Altonaga 1986, 1989a) and *O. basajauna* n. sp., described here.

DIAGNOSIS

Proximal portion of penis short, flattened and wide, with a obcordiform appearance; inside, it has 30–35 thin and very sinuous longitudinal folds. Distal portion cylindrical.

DESCRIPTION

Body: Dark bluish-grey or cream coloured, sometimes spread all over the body, and at others relatively intense at the neck and the dorsal zone, paling on the flanks to become darker again at the tail. The mantle-edge has a strip of the same type but darker in colour than the neck. The sole is tripartite, of the same colour but of a lighter shade than the dorsal zone; the external longitudinal bands are at times the same shade as the back, with only the central one being paler.

Shell (Fig. 1 and Pl. 30): The shell is depressed, the spire usually raised, with relatively convex whorls which show a clear shallow suture. The $4\frac{3}{4}$ – $5\frac{5}{8}$ whorls expand slowly and progressively, the last 1.5 times broader than the previous one. The mouth is oval, or more often

¹Animali Biologia eta Genetika Departamentua, Universidad del País Vasco/Euskal Herriko Unibertsitatea. Posta-Kutxa: 644, 48080-Bilbao, Spain.

rounded and slightly oblique. The mouth-edge is simple and unreflected. The umbilicus is deep and narrow, with one whorl visible; it is 1/10 of the maximum diameter. The shell is fragile, translucent, very shiny, reddish-brown or yellowish-amber in colour, paler above and nearly white around the umbilicus. It displays distinct transverse microsculpture, with no trace of spiral microsculpture. Dimensions: d: 10.1–13.0 mm; h: 4.8–6.9 mm.

Genitalia (Figs. 2–4): The genital system follows the typical *Oxychilus* Fitzinger, 1833 layout, and is crossed by the right ommatophore. The total penis length is 5.0–7.5 mm. The proximal portion of the penis is short, flattened, wide and inverted-heart-shaped; the distal portion is longer and cylindrical, and of similar width throughout its length, although it may be slightly thicker about the atrium. There is a penial veil which loosely covers nearly all this distal part. The flagellum is small, 1/5–1/10 of the total penis length, or sometimes even shorter; it would be the crown of an upside-down heart, and thins quickly, showing a rounded end. The penis retractor muscle is thick, compact, usually long, and is apically inserted into the flagellum's rounded end. The epiphallus is somewhat over 1/2 the penis length, though in some cases it may be of the same size. It is slightly thickened where it meets the vas deferens, the latter being slender and longer than the penis.

The genital atrium is insinuated. The vagina is of variable length: it may be as long as the penis, or only 1/2 its length. It is roughly the same width as the distal part of the penis, or sometimes thinner. There is a well developed perivaginal gland surrounding the vagina, which sometimes reaches almost to the atrium. This gland also surrounds the base of both the spermathecal duct and oviduct. Generally the latter is short and thick, although in some cases it may be half as long as the vagina. The spermathecal duct is very stout, especially at its base, and short, sometimes of the same length as the spermatheca itself, which may be oval, almost sphaerical or extended. At times, a strip-like red spermatophore has been observed by transparency inside the spermatheca. The vagina together with the oviduct is similar in length to the penis, so the whole structure displays a symmetrical appearance.

The inner proximal part of the penis shows folds which originate in the flagellum, and run lengthwise towards the distal part. 30–35 parallel bands may be noted, running in a wavy, very sinuous shape along for most of the way; in fact, some zones have a baroque appearance, since the bands are superimposed due to their great number. Around the insertion of the epiphallus the striped pattern is different, with an almost radial, pleated structure being developed.

Radula: 14–16 M/1 + 2 L/3 + C/3 + 16–18 × 40–42.

COMMENTS ON THE DESCRIPTION

Oxychilus basajauna n. sp. shows some anatomical characteristics—shape and interior construction of the penis—that clearly differentiate this species from all the species in the genus *Oxychilus*. It may be closely related to *O. helveticus*, which it resembles in its shell and the female portion of the genital system. However, rather than the great variability in both external morphology and internal structure of the genital system of *O. helveticus* (Riedel 1970, 1972, Altonaga 1989b), a clearly different and constant pattern has been observed in *O. basajauna*.

On the other hand, in *O. basajauna*, the inner structure of the penis is banded, which places it in the subgenus *Ortizius* Forcart, 1957. Thus the presence of sinuous bands in the penis of *O. basajauna* more or less forces it into a taxon defined by the presence of simple bands (Forcart 1957, Riedel 1966, 1980); this fact shows again how right Manganelli &

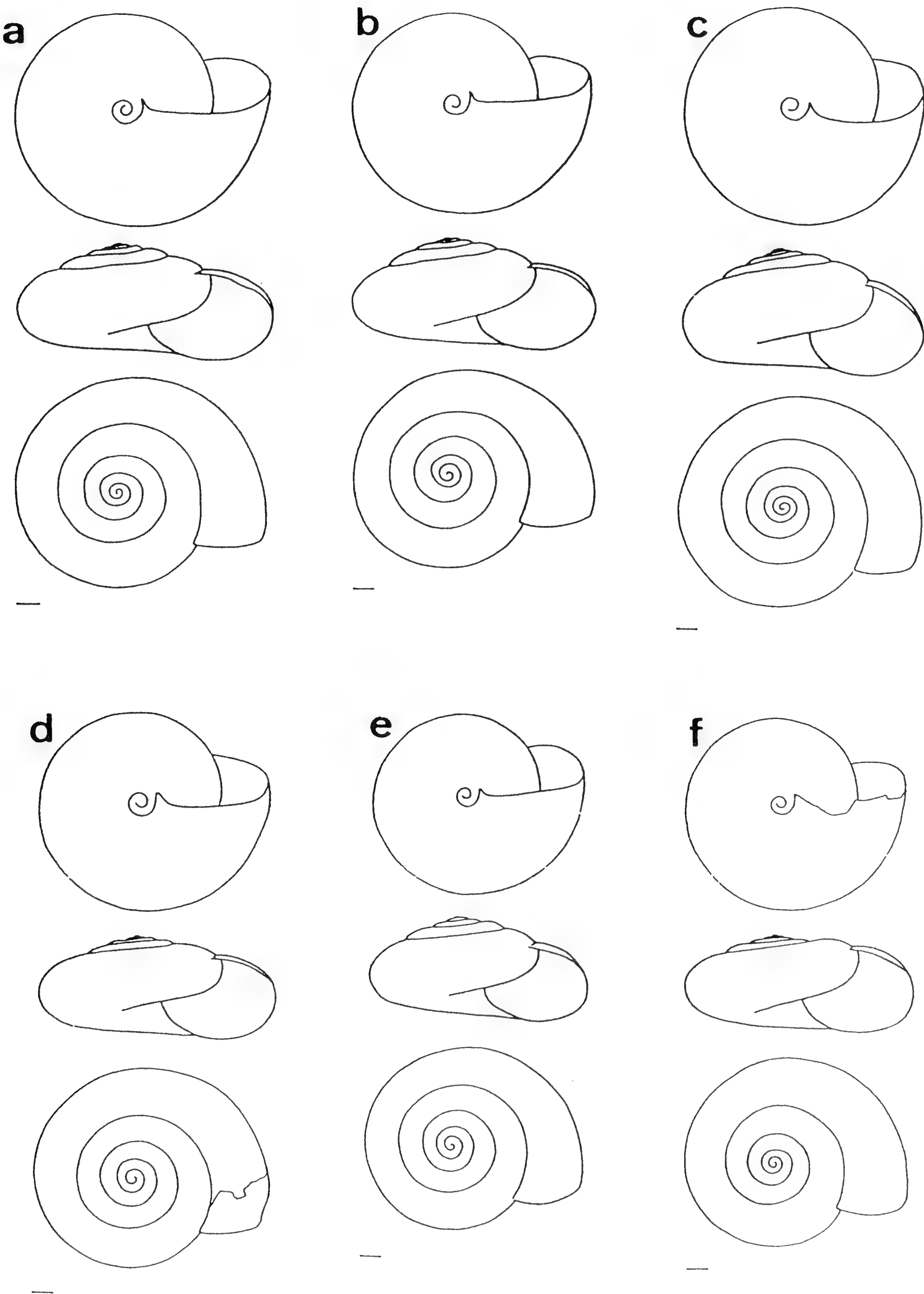


Fig. 1. *Oxychilus basajauna* n. sp.: shells.
a Errezil (3360-1); b Errezil, holotype (3360-2); c Errezil (3360-3); d Errezil (3360-4); e Errezil (3360-5);
f Hernialde (3300-1). Scale bar: 1 mm.

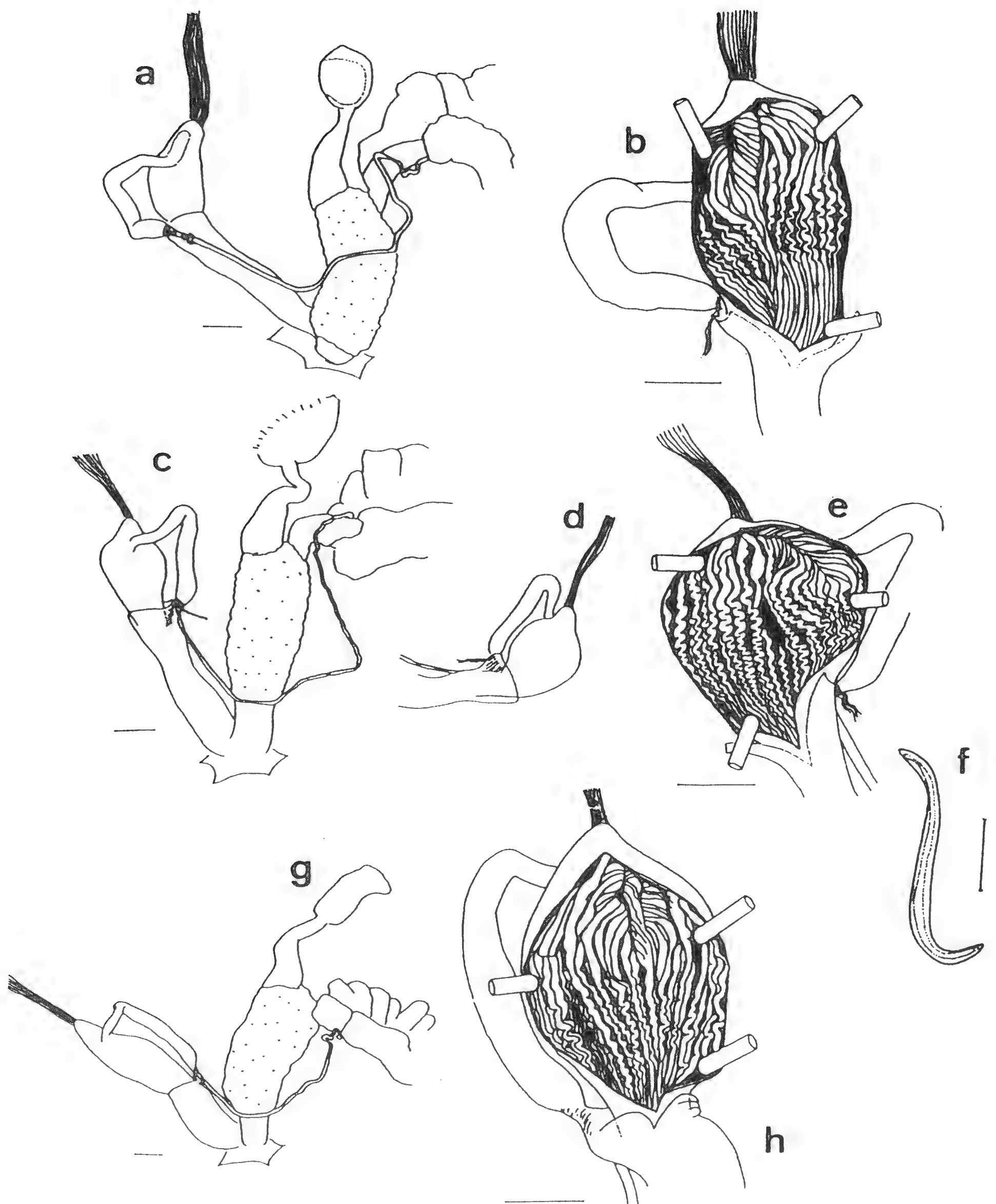


Fig. 2. *Oxychilus basajauna* n. sp.: external morphology of genital system, detail of penis and its inner construction, and spermatophore. a-b Errezil (3360-1); c-f Errezil, holotype (3360-2); g-h Errezil (3360-3). Scale bar: 1 mm.

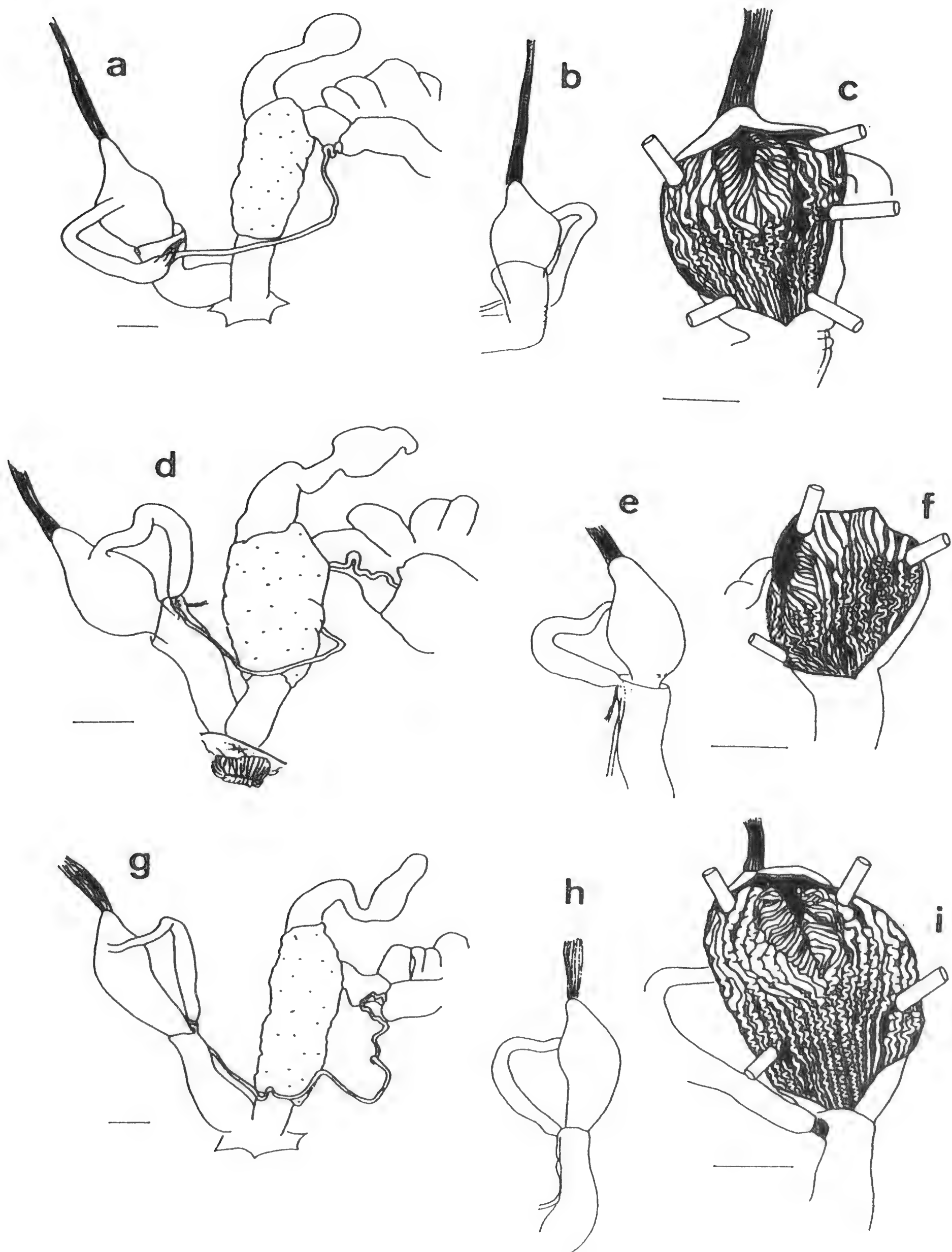


Fig. 3. *Oxychilus basajauna* n. sp.: external morphology of genital system, detail of penis and its inner construction. a-c Errezil (3360-4); d-f Errezil (3360-5); g-i Hernialde (3300-1). Scale bar: 1 mm.

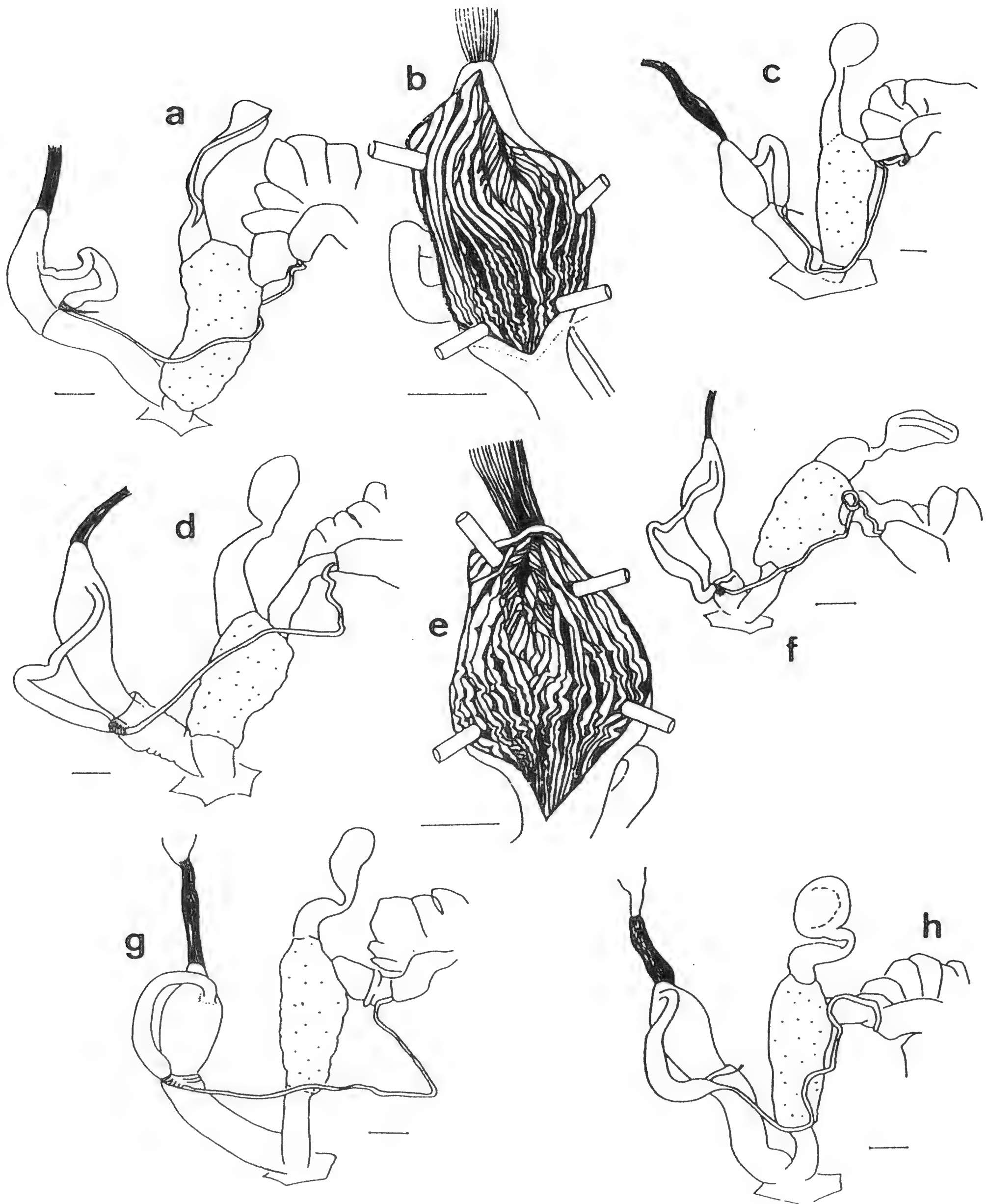
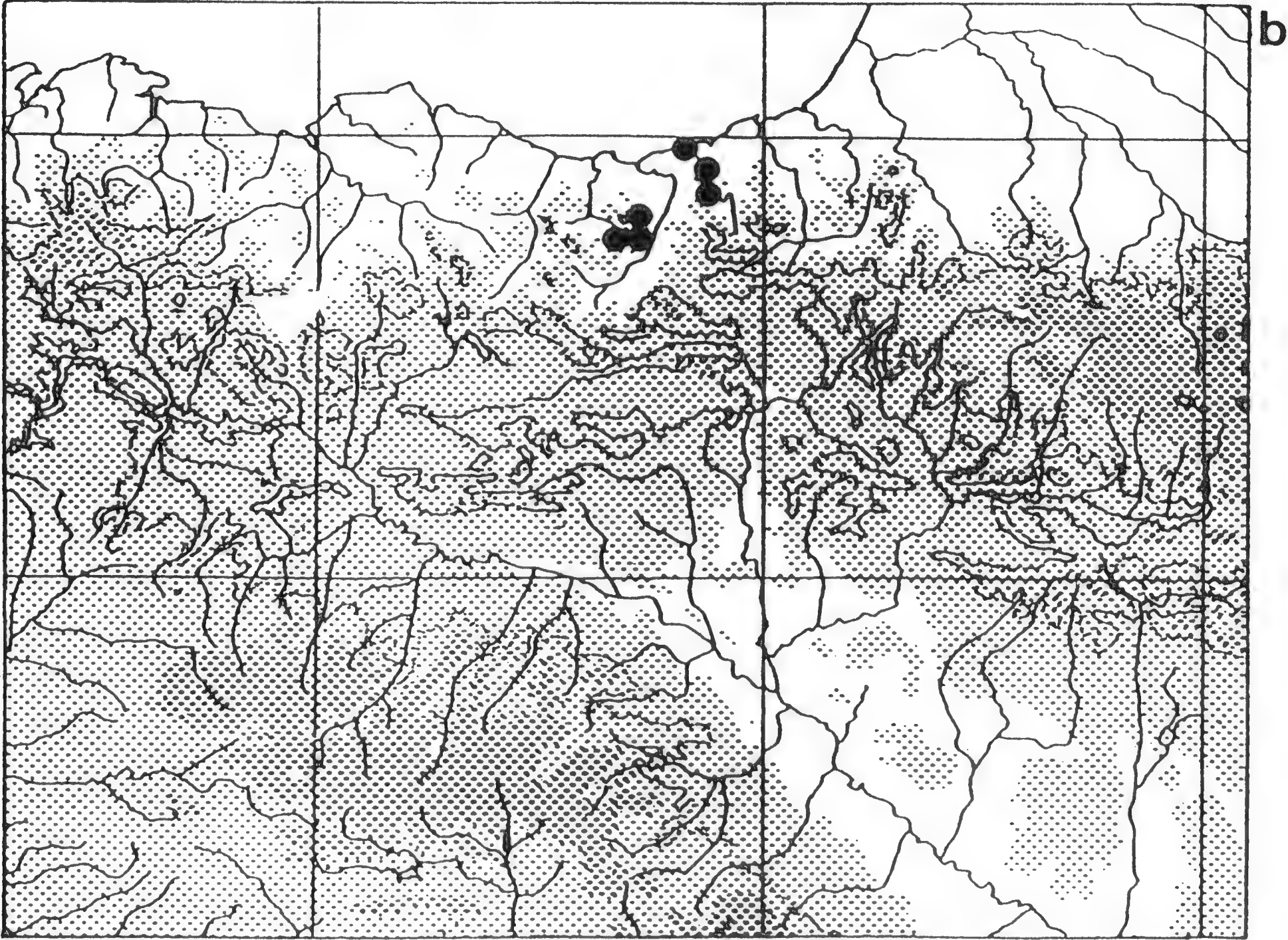
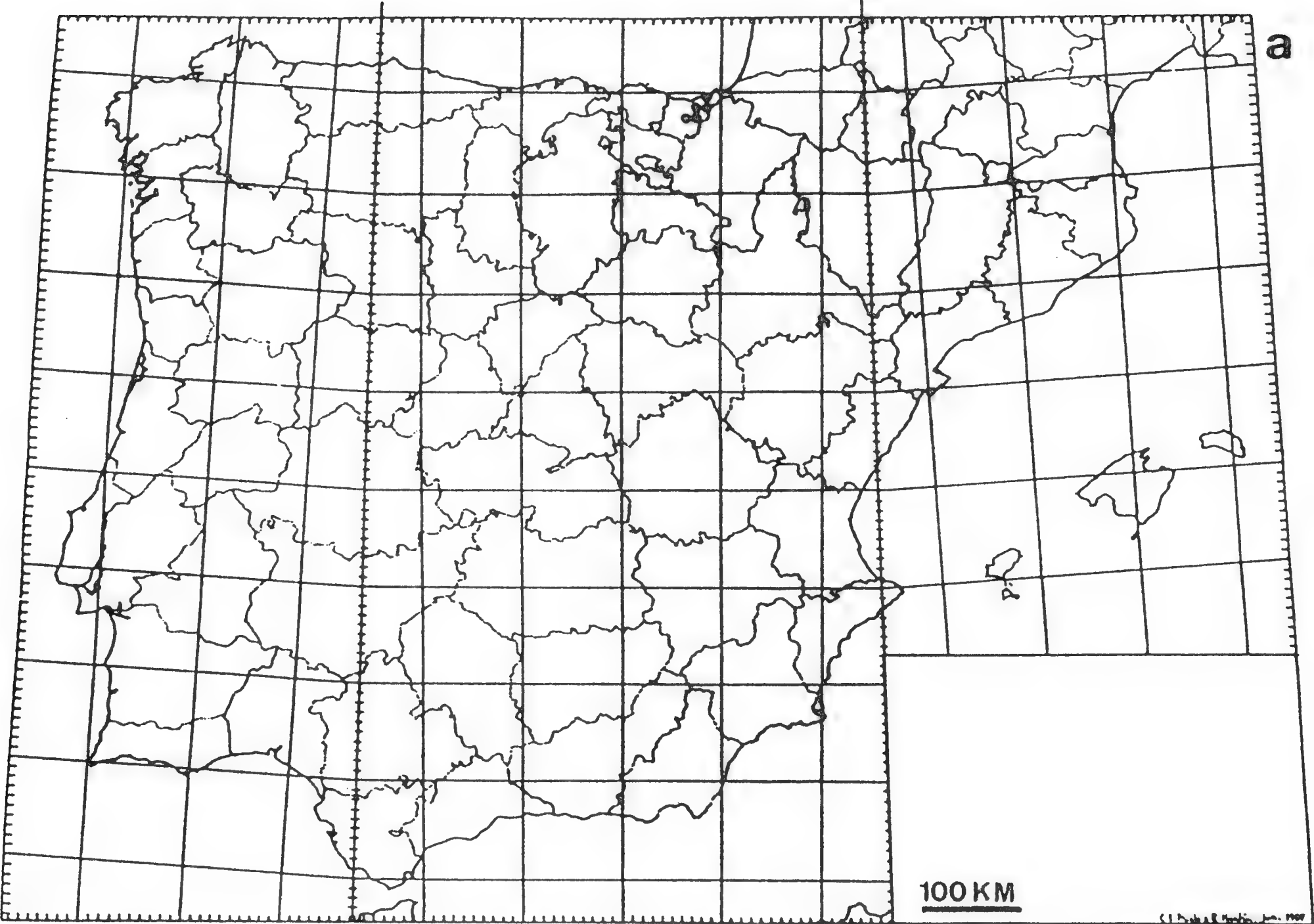


Fig. 4. *Oxychilus basajauna* sp. n.: external morphology of genital system and penis inner construction. a–b Hernialde (3300–2); c Astigarraga (p. 178–1); d–e Donostia-San Sebastián (3092); f Alkiza (p. 181–1); g Ereñotzu (p. 179–1); h Astigarraga (p. 178–2). Scale bar: 1 mm.

Fig. 5. *Oxychilus basajauna* n. sp.: geographical distribution. a in Iberian Peninsula (UTM notation of 10 km \times 10 km squares); b detail of Basque Country (UTM notation of 5 km \times 5 km squares).

ALTONAGA: *OXYCHILUS BASAJAUNA*



Giusti (1985) were when they said that more data are necessary to elucidate the real taxonomic value of the subgenus *Ortizius* Forcart, 1957. Meanwhile, we prefer to regard *Ortizius* as a polymorphous taxon (Altonaga 1989a), as Giusti, Boato & Bodon (1986) have stated with the genus *Retinella*.

MATERIAL STUDIED

Holotype: Errezil (Gipuzkoa, Spain), 30TWN6779, K. Altonaga, B. Gomez and R. Martin leg. 1986.03.23.; in coll. K. Altonaga/LZB-MOL-3360-2.

Paratypes: Alkiza (Gipuzkoa), 30TWN7280, C. Prieto and R. Martin leg. 1987.12.04.; 13 spec., 4 shells; in coll. KA/p.181. Astigarraga (Gipuzkoa), 30TWN8693, C. Prieto and R. Martin leg. 1987.12.04.; 20 spec., 6 shells; in coll. KA/p.178. Donostia-San Sebastián (Gipuzkoa), 30TWN8197, M. Etxaide leg. 1981.02.22.; 1 spec.; in coll. KA/LZB-MOL-3092. Ereñotzu (Gipuzkoa), 30TWN8688, C. Prieto and R. Martin leg. 1987.12.04.; 56 spec. in coll. KA/p.179 and 6 spec. in coll. Polska Akademia Nauk (Warsaw). Errezil (Gipuzkoa), 30TWN6779, K. Altonaga, B. Gomez and R. Martin leg. 1986.03.23.; 6 spec; in coll. KA/LZB-MOL-3360. Errezil (Gipuzkoa), 30TWN6779, K. Altonaga and A. I. Puente leg. 1987.11.22.; 2 spec. and 3 shells; in coll. KA/LZB-MOL-3738. Hernialde (Gipuzkoa), 30TWN7478, K. Altonaga, B. Gomez and R. Martin leg. 1986.03.23.; 6 spec.; in coll. KA/LZB-MOL-3300. Hernialde (Gipuzkoa), 30TWN7478, C. Prieto and R. Martin leg. 1987.12.04.; 1 spec. and 8 shells; in coll. KA/p.180.

HABITAT AND GEOGRAPHICAL DISTRIBUTION

The distribution of *O. basajauna* n. sp. seems to be a neoendemism with a very restricted geonemy. It lives under stones and wood in both relatively exposed and sheltered places, with calcareous substrates and high humidity. It has been collected only at six localities in Gipuzkoa (Spain) (Fig. 5), in the Oria and Urumea River valleys, taking up a narrow fringe about 30 km long. Curiously, this area corresponds to the blank space that Gipuzkoa shows in the distribution of *O. helveticus* (Altonaga 1989b); consequently, since they take up a very similar escenopoetic niche, we can assume that *O. basajauna* has 'displaced' *O. helveticus* from this area. Obviously, it might also be supposed that *O. basajauna* has evolved locally from former *O. helveticus* populations.

SIMILAR SPECIES

Externally, *Oxychilus basajauna* is very similar to *O. helveticus* and *O. anjana*. The pattern of body colouring in these three species is very similar; moreover, the typical dark pigmented band in the mantle-edge of *O. helveticus* (Kerney & Cameron 1979) also occurs in *O. basajauna* and *O. anjana*.

The shell of *O. basajauna* is usually bigger and with more whorls than *O. helveticus*, but still retaining the characteristics of *O. helveticus*, so that the distinctive criteria of *O. basajauna* are very elusive. The umbilicus is of similar width in both species. The reddish colouring, seen, sometimes, on fresh shells of *O. basajauna* is characteristic, but this should be treated with great caution. Only the genital morphology of *O. basajauna* clearly differentiates it from *O.*

ALTONAGA: *OXYCHILUS BASAJAUNA*

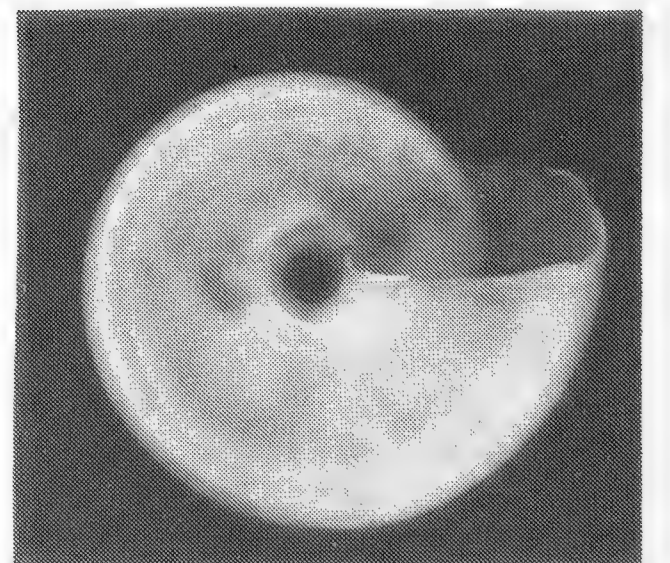
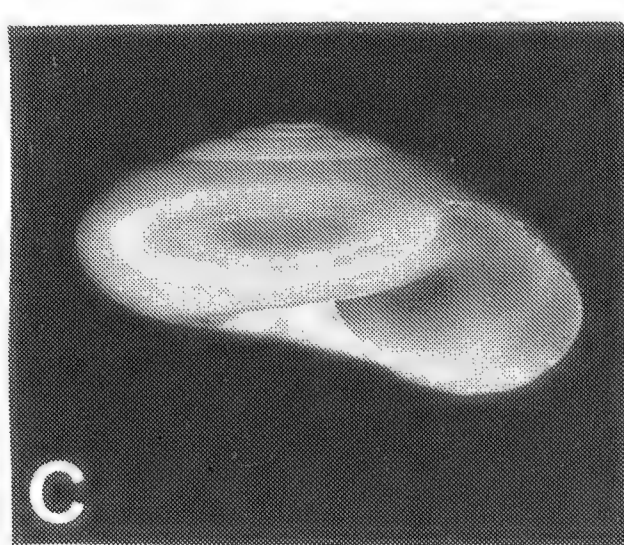
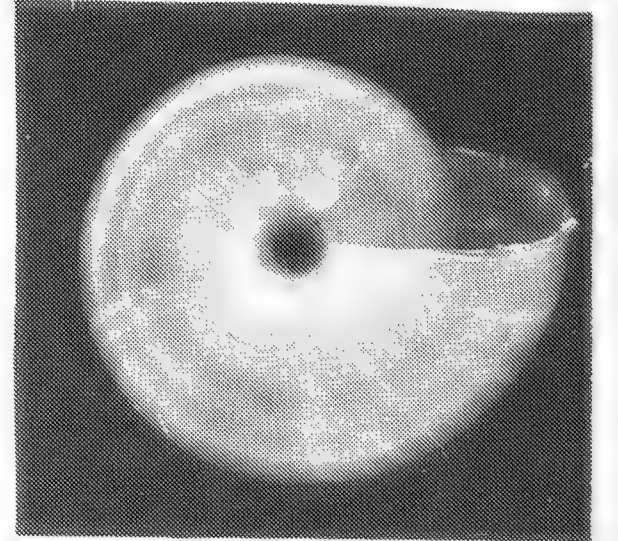
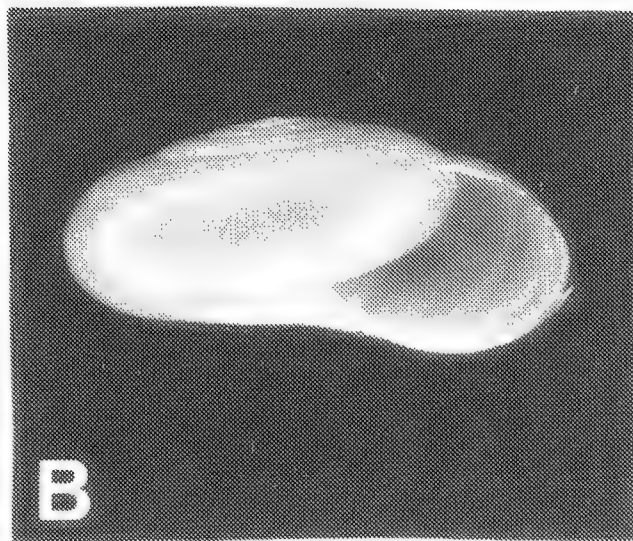
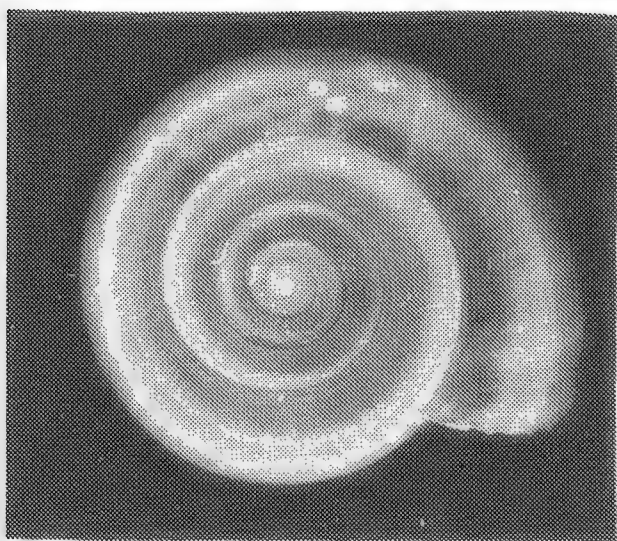
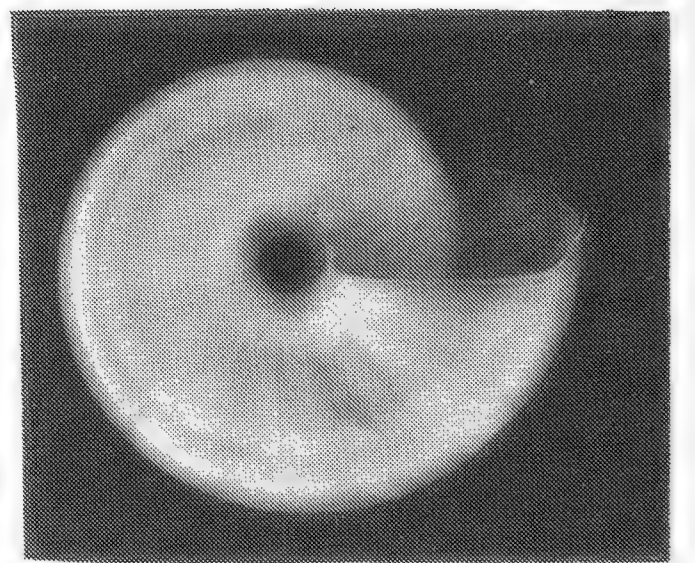
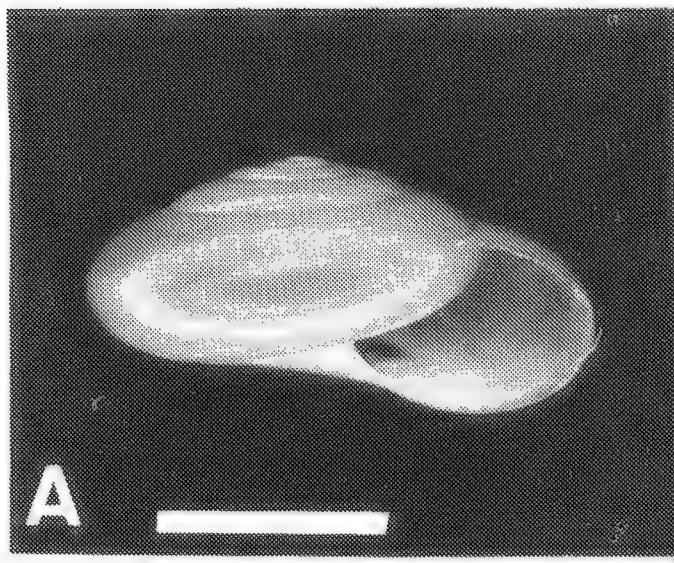
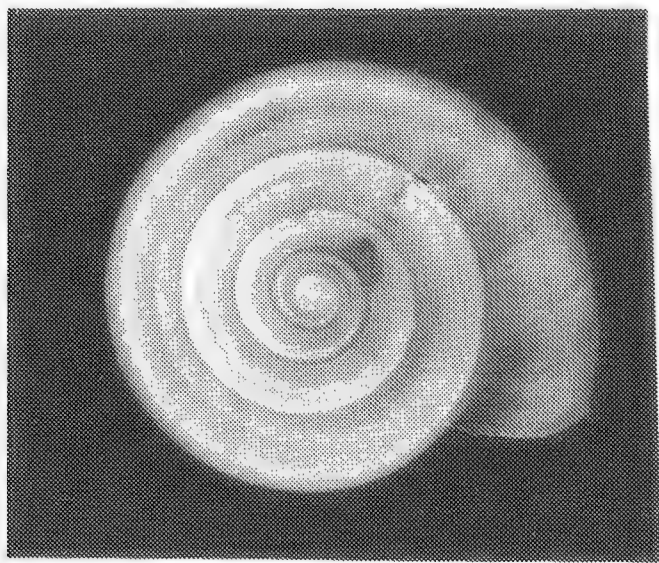


PLATE 30

Oxychilus basajauna n. sp. and *Oxychilus helveticus* (Blum 1881): shell. a *O. basajauna*: Holotype, Errezil (Gipuzkoa, Spain), KA/LZB-MOL-3360-2. b *O. basajauna*: Paratypes, Astigarraga (Gipuzkoa, Spain, KA/LZB-MOL-p. 178-2. c *O. helveticus*: Ataun (Gipuzkoa, Spain), KA/LZB-MOL-3455. Scale bar: 5 mm.

helveticus and this is the only reliable way to identify this species. The characteristic proximal portion of the penis makes *O. basajauna* unmistakable. Furthermore, the inner construction of the penis is unequivocal. Although specimens of *O. helveticus* showing undulating bands also occur, there are never more than a dozen such bands, and they are much less wavy than in *O. basajauna*. The female part of the genital system does not present evident differences.

Oxychilus basajauna and *O. anjana* are, conchologically, very similar species; however, the anatomical differences between them are conspicuous.

DERIVATIO NOMINIS

The name 'Basajauna' has been taken from the deity of popular mythology that inhabited the woodlands in that area. Basajaun, the lord of the forests, has a tall, humanoid body, and his long head of hair hangs down to his knees; he is the guardian spirit of the flocks; at other times he is described as the first farmer, from whom humans learned how to grow grain, and as the first blacksmith and the first miller, from whom the secrets of making the saw and the mill axle and welding metals were robbed by men (Barandiaran 1979).

ACKNOWLEDGEMENTS

We would like to express our thanks to Dr. A. Riedel (Poland) who kindly surveyed our data.

This research was supported in part by the Basque Government (Hezkuntza, Unibertsitate eta Ikerketa Saila: X-86.044 project).

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THE OCCURRENCE OF THE GENUS *NEUMAYRIA* (GASTROPODA: BITHYNIIDAE) IN THE BRITISH LOWER PLEISTOCENE

R. C. PREECE¹

(Accepted for publication, 21st October 1989)

Abstract: Shells belonging to the bithyniid genus *Neumayria* have been recognized amongst a limited non-marine fauna from the marine Norwich Crag Formation at Bulcamp Union Farm, Suffolk. The species involved is uncertain. It is smaller than *N. crassitesta* (Brömme), the commonest species of the genus found in Quaternary deposits on the continent, and is tentatively referred to *N. priscillae* Girotti, a species known from the Plio-Pleistocene of Italy, France and The Netherlands.

The Norwich Crag at Bulcamp (occasionally Bulcham or Bulchamp in the early literature) is a famous locality for fossils and records from here date back to the middle of the last century (Wood 1848). Prestwich (1871) gives more precise details of the pits on the north side of the Blyth Valley 'near Bulcamp Union' but these classic sections are now long overgrown. In 1979, the Geological Society of Norfolk, assisted by the Ipswich Geological Group, re-excavated sections in the largest disused pit at TM 4420 7545 (Cambridge 1982). A preliminary list of fossils, together with details of the sedimentology of this new section has been given by Funnell (1983) who concluded that the deposits were either Antian or Bramertonian in age. A shallow-water (inner sublittoral to intertidal) environment, probably near the mouth of an estuary, was suggested. A fuller account of the palaeontology, with specialist contributions on various groups, is in preparation.

The occurrence of non-marine Mollusca in these shallow marine deposits was noted by all the early workers and all the species they recorded have been recovered from samples taken from the new sections. At least nineteen non-marine taxa are now known from this site (Preece 1990) including several extinct species (e.g. *Viviparus medius*, *Ellobium pyramidale* and *Sphaerium icenicum*).

This note records the occurrence of another extinct form from Bulcamp. At least two species of bithyniid prosobranchs were recovered from the new sections. One appears to match modern shells of *Bithynia tentaculata* but much of the fossil material is fragmentary and worn and so can only be tentatively referred to this species (Figs. 3–4). A second species is much larger and more loosely coiled than *B. tentaculata* and has a thicker shell with a blunter apex (Figs. 1, 2a, b). Comparison with continental material leaves no doubt that this belongs to a species currently assigned to the genus *Neumayria* De Stefani, a genus hitherto unrecognized in the British Quaternary.

Meijer (1974) has reviewed the Bithyniidae in the Dutch Quaternary and gives illustrations of all the forms that occur there including *Neumayria crassitesta* (Brömme). This is a large species (height up to 16 mm, breadth 9 mm) which is known from several temperate stages from the Tiglian (Lower Pleistocene) to the Holsteinian (Middle Pleistocene). A smaller form, resembling *N. priscillae* Girotti, is also known from the Dutch Middle and Late Tiglian (T. Meijer, personal communication). Meijer (1974) has also pointed out that paucispiral opercula, previously thought to be those of *Lithoglyphus naticoides*, are in fact those

¹Department of Zoology, Downing Street, Cambridge CB2 3EJ

of *Neumayria* and that these are readily separable from those of *Bithynia*, which are mainly concentric, except for a small paucispiral nucleus.

The Bulcamp *Neumayria* are much smaller (height 9.6 mm; estimated breadth 5.45 mm) and have a much shorter spire than *N. crassitesta*. However, they approach *N. priscillae* Girotti to which they are tentatively referred. Since only one adult *Neumayria* is known from Bulcamp (Fig. 2a,b), a final opinion must await the discovery of more material. No bithyniid opercula have yet been recovered from Bulcamp but all those from other sites in the Norwich Crag Formation have proved to belong to *Bithynia*.

N. priscillae was described by Girotti (1972) from Italian deposits ranging in age from Miocene/Pliocene to Late Villafranchian. Outside Italy it is known from several other localities in France and The Netherlands of similar or slightly later date (T. Meijer in prep.). It appears to have been less widespread than *N. crassitesta* and, unlike this species, is not known with certainty after the Late Tiglian. From the presence of *Macoma praetenuis* and absence of *M. balthica*, it would appear that the Bulcamp deposits correlate with the Dutch Middle Tiglian (cf Meijer 1988). This suggestion is supported by vertebrate evidence (D. F. Mayhew, unpublished data). The presence of *N. priscillae* at Bulcamp therefore matches its known stratigraphical range in The Netherlands.

Tom Meijer is currently undertaking a comprehensive revision of the Bithyniidae from the European Neogene and Quaternary which will include a discussion of the generic status of *Neumayria* and its affinities with extant taxa in Asia (Meijer in prep.).

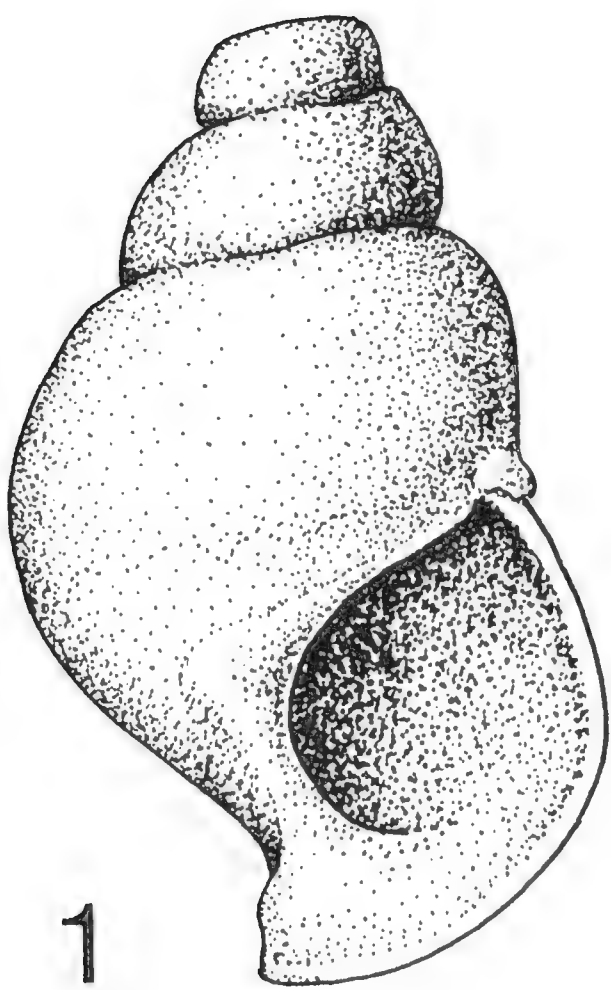
ACKNOWLEDGEMENTS

I thank Mr. P. G. Cambridge and Dr. P. E. Long for allowing me to work on their material from Bulcamp and Tom Meijer (Rijks Geologische Dienst, Haarlem) for much valuable discussion and the opportunity to examine continental *Neumayria* and a draft of his unpublished paper on the subject.

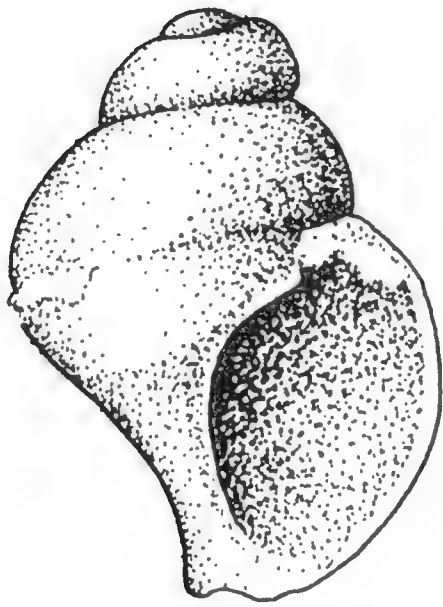
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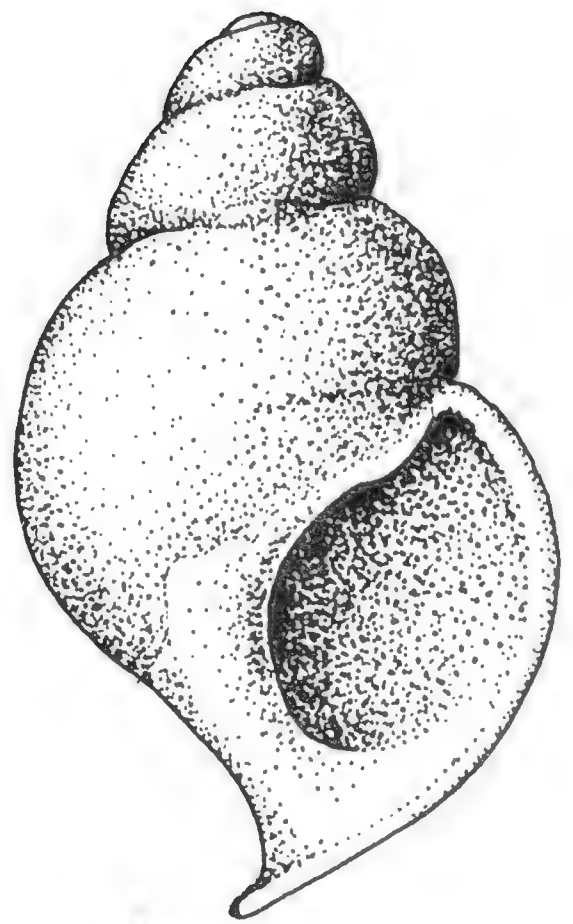
Figs. 1–4. Bithyniidae from the Norwich Crag Formation at Bulcamp Union Farm. Scale bar = 1 mm.
Figs. 1–2 *Neumayria* cf *priscillae* Girotti. Figs. 3–4 cf *Bithynia tentaculata* (Linné).



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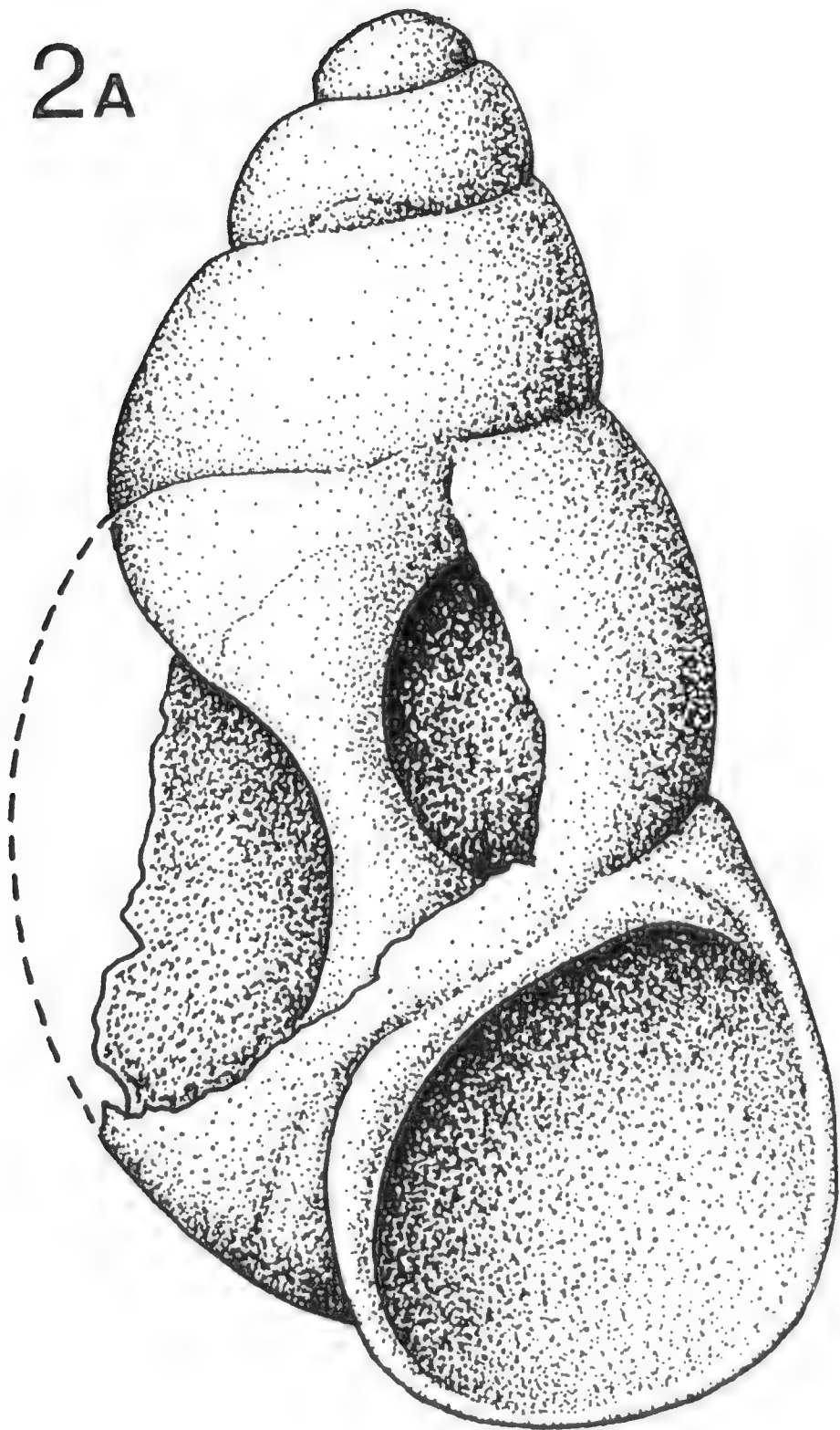
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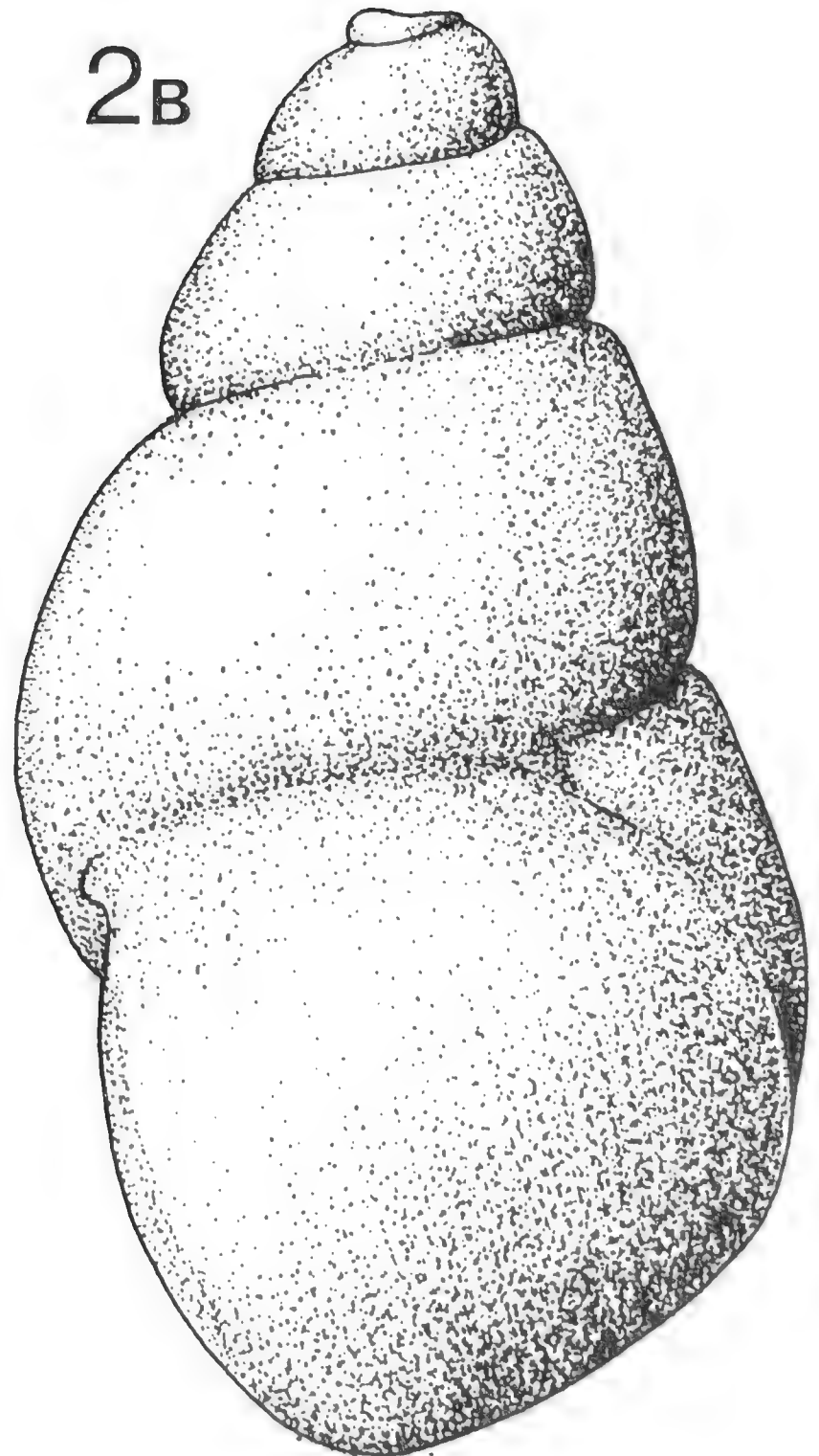
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2A



2B



THE MOLLUSCAN FAUNA OF LATE DEVENSIAN LOESS FROM RECULVER, KENT

R. C. PREECE¹

(Accepted for publication, 21st October 1989)

Abstract: A sample of 'head brickearth' from Reculver, Kent, yielded a typical loess fauna comprising *Pupilla muscorum*, *Succinea oblonga*, *Columella columella*, *Trichia hispida* and *Deroceras* sp. Thermoluminescence dates in the range 17–23,000 years BP, demonstrate that this loess accumulated during the early part of the Late Devensian.

Periglacial aeolian deposits are quite widespread in parts of England and Wales but they are often rather thin (<0.3 m), weathered and re-worked (Catt 1977, 1979). However, in the east of Kent rather thicker deposits, exceeding 1 m, occur. The most intensively studied sections are at Pegwell Bay on the Isle of Thanet where true aeolian loess blankets Thanet Beds, shattered Chalk and coombe rock, heavily cryoturbated in its upper part (Pitcher *et al.* 1954, Kerney 1965). The last author also reported additional occurrences of loess in gentle depressions in the surface of the Chalk at Dumpton Gap (TR 397665), Palm Bay (TR 370714) and North Cliff Broadstairs (TR 400685). At the last site, the loess occurred stratigraphically below a full Late-glacial colluvial sequence with two palaeosol horizons (Kerney 1965, Pl. 8), which suggested loess deposition during the early part of the Late Devensian. This suggestion has recently been confirmed by thermoluminescence (TL) dates which fall in the range 14–18,000 years BP for the Pegwell Bay loess (Wintle 1981, Parks & Rendell 1988).

There is a general belief that the Kentish loesses are unfossiliferous due largely to their decalcified nature (e.g. Keen 1987, p. 258). However, as Kerney (1965, p. 270) pointed out only the upper 1.25 m of the profiles are decalcified and so this cannot be the whole reason. Indeed, Pitcher *et al.*, (1954) clearly imply that they did recover land snails from the Pegwell Bay loess but give no further details. Hitherto the only molluscan faunas described from British loess come from the Channel Islands (Keen 1982, Rousseau & Keen 1989).

This paper describes the first molluscan fauna from true loess from the British mainland. At the eastern end of Herne Bay near Reculver (TR 204693), the Thanet Beds are capped by loess which can reach 3 m in thickness but which is generally somewhat thinner. The loess, mapped as 'head brickearth' by the Geological Survey, is inaccessible for much of the length of the section due to the height of the cliffs. However, in April 1975 a cliff-fall brought down a small section of the upper levels and enabled sampling of the loess. This was very similar to that described from Pegwell Bay being yellowish, structureless and in possessing prismatic jointing. On immersion in water the sample collapsed completely revealing abundant tiny tubular concretions that had evidently formed around rootlets. The sample (~1.5 kg) was also very shelly, yielding the following taxa:

| | |
|--|------|
| <i>Pupilla muscorum</i> (Linné) | 1034 |
| <i>Columella columella</i> (von Martens) | 10 |
| <i>Succinea oblonga</i> Draparnaud | 444 |
| <i>Trichia hispida</i> (Linné) | 12 |
| <i>Deroceras</i> sp | 1 |

¹Department of Zoology, Downing Street, Cambridge CB2 3EJ

Several calcareous granules were also recovered that have, in the past, been said to come from slugs of the genus *Arion* but which some authorities now think are produced by lumbricid worms.

The Kennard collection in the British Museum (Natural History) contains a series of shells collected from 'Reculver'. These are identical to those obtained during the present study and obviously came from the same source.

The loess at Reculver is not fossiliferous throughout. At the eastern extremity of the outcrop where it reaches its thickest extent and fills a small hollow where the cliffs lose height, it is decalcified and lacks shells. A series of samples for thermoluminescence dating were taken at this point by Mr. D. A. Parks and Dr. H. M. Rendell. Their results fall in the range 17–23,000 years BP and again demonstrate that the Reculver loess, like that at Pegwell Bay, is Late Devensian in age (Parks & Rendell 1988 and *pers. comm.*).

The fauna from the Reculver loess is identical to that described from Portelet, Jersey, which appears to be approximately similar or slightly earlier in age (Rousseau & Keen 1989). The same five taxa were also recovered from a periglacial deposit of loessic character in the Medway Valley at Halling (Kerney 1971), some 50 km west of the other Kentish sites (Fig. 1). This monotonous fauna clearly reflects an open periglacial environment and would appear to characterize loessic sediments of this age in this part of western Europe. However, much more diverse faunas are known from this time from central Europe (e.g. Ložek 1964).

Ecologically the fauna presents something of a puzzle as its two dominant elements are normally said to typify contrasting humid (*Succinea*) and dry (*Pupilla*) environments. Kerney (1971) discusses plausible interpretations for these apparently mixed ecological elements. All I can add is the observation that *Pupilla muscorum* does occur in marshes, often quite commonly, alongside succineids such as *Oxyloma pfeifferi* and other hygrophilous taxa. This is especially true of marshes bordering brackish creeks and estuaries and it is interesting to note that the *Pupilla* from such places are often unusually tall and approach the morphology of the loess shells.

ACKNOWLEDGEMENTS

I thank David Parks and Helen Rendell for including Reculver in their dating programme of brickearths in southern England.

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Fig. 1. Quantitative comparisons of the molluscan faunas from British loessic sediments: Halling, 490–500 cm (Kerney 1971), Portelet, Jersey (Rousseau & Keen 1989), Reculver, Kent (this study).

UNDESCRIBED QUATERNARY LAND-SNAIL SPECIES FROM SW PORTO SANTO (MADEIRAN ISLANDS) (MOLLUSCA: GASTROPODA)

MARY B. SEDDON¹

(Accepted for publication, 21st October 1989)

Abstract: Undescribed fossils from Quaternary deposits on SW Porto Santo are named as *Leiostyla espigaoensis* sp. nov., *Leiostyla subcorneocostata* sp. nov. (Pupillidae) and *Actinella (Faustella) morenensis* sp. nov. (Helicidae).

INTRODUCTION

Porto Santo (Madeiran Islands) was visited in February 1986 in order to collect well-stratified samples of Quaternary Mollusca from three locations where Dr. D. T. Holyoak and I had taken a few preliminary samples in December 1984. Material was also collected from exposures in the valley above Porto da Morena at the south-western corner of the island from which *Geomitra acarinata* Hemmen & Groh, 1985 has recently been described. Laboratory study of sediment samples from this valley yielded numerous shells of *Leiostyla* (Pupillidae) and *Actinella* (Helicidae) that could not be identified with species already known from Porto Santo.

Detailed comparisons with abundant material from Porto Santo and Madeira in the National Museum of Wales (NMWZ) (including the Holyoak & Seddon Collection) and figures in the review of *Leiostyla* by Pilsbry (1922–3) revealed that these were undescribed species.

Samples were collected from three different exposures within the valley and several distinct strata within two of the sections. These will be described more fully in a paper that is in preparation discussing the late Quaternary deposits, molluscan fossils and environments of E. Madeira and Porto Santo.

***Leiostyla espigaoensis* sp. nov. (Plate 31 A)**

Description: The rather strong and solid shell has 5.5–6.5 whorls. The whorls are swollen and convex, separated by impressed sutures. The first three whorls taper towards the apex and occupy about one-quarter of the shell height. The later whorls are cylindrical; the penultimate and body-whorls occupying about two-thirds of the shell height. The surface of the shell has strong, prominently raised whitish ribs which are widely and evenly separated with 5 ribs per mm on the body whorl (closer on the upper whorls). The protoconch and first whorl are smooth. The aperture is rounded-triangular. The peristome is almost continuous, with a small callus continuing across the parietal wall. The lip is slightly reflected. There are seven whitish apertural teeth. The somewhat curved angular tooth (upper parietal) emerges as far as (or further than) the angular callus. It is a large prominent tooth which disappears

¹School of Geography and Geology, College of St Paul and St Mary, The Park, Cheltenham, Glos. GL50 2RH and Department of Zoology, National Museum of Wales, Cathays Park, Cardiff CF1 3NP

from view well within the mouth. A prominent up-standing angular callus extends from the palatal wall to the base of the angular tooth. The straight lower parietal tooth is almost as tall as the angular tooth but does not emerge onto the outer lip. There is a small callus developed high on the palatal wall, opposite the end of the angular tooth from which it is separated by a narrow gap. The weak upper palatal tooth is also close to and nearly opposite the angular tooth. It emerges part way onto the outer lip and extends a small distance back into the mouth, running parallel with the end of the angular tooth. The curved lower palatal, in contrast, is strongly developed; it does not extend far onto the outer lip, but the tooth becomes higher as it extends back within the mouth before disappearing from view. The upper columellar tooth is not always present; it is small and curves back under the parietal wall. The main columellar tooth does not emerge onto the outer lip; it begins as a low callus which develops into a high straight tooth and disappears from view deep in the mouth. The basal tooth is situated at the base of the mouth. It is a small, deeply recessed tooth, becoming more strongly developed deep within the mouth and extending back until it disappears from view. The remaining shell colouration is light brown with no evidence of banding.

Measurements: Holotype height 3.2 mm, breadth 1.7 mm; Paratypes within the range 2.9–3.4 × 1.6–1.8 mm.

Derivatio nominis: Adjective based on the hill to the north of the type locality, Espigão.

Comparisons: The shells resemble modern material of *Leiostyla calathiscus* (Lowe, 1831) in the form of the ribbing, but are smaller and proportionately narrower with a more bluntly rounded (less pointed) shell apex and a narrower, more elongate shell-mouth. *L. calathiscus* lacks an upper columellar tooth and has less-strongly developed teeth which do not extend as far back within the shell mouth. Fossil shells of *L. calathiscus* are smaller than modern shells but even these fossils are slightly longer and distinctly broader than *L. espigaoensis*. Both species occur at one stratigraphic level in the calcarenite.

It is larger than *L. monticola* (Lowe, 1831) and *L. degenerata* (Wollaston, 1878) with stronger, more prominent ribbing, a proportionately narrower mouth and a more expanded peristome. The supra-palatal tooth of *L. monticola* is absent in *L. espigaoensis* although there is a small low, rounded swelling on the outer lip; the upper palatal tooth of *L. espigaoensis* is not as well developed as that of *L. monticola*. Otherwise the teeth are generally similar to those of *L. monticola*, but differ slightly in their size and position within the mouth. *L. degenerata* has fewer and smaller teeth.

Type Locality: By track on NW side of the valley, c. 1 km NE of Porto da Morena, Porto Santo. Collected from the upper calcarenite beds (at 1.5 m depth) underlying colluvium exposed in a bank beside the track.

Material examined: Besides the Holotype (lodged in the National Museum of Wales as NMWZ 1989.098.01) there are 151 paratypes; one of which has been lodged in the Collection of the British Museum (Natural History). This species was also found in samples from different stratigraphic levels within the calcarenite. It is present in similar deposits on the SE side of the valley approximately 200 m away. One shell was also found in calcarenite c. 1 km W of Cabeço da Ponta on the S. coast of Porto Santo.

***Leiostyla subcorneocostata* sp. nov. (Plate 31 B)**

Description: The shell has 5–6 whorls that are convex, rather swollen and separated by impressed sutures. The first two whorls taper abruptly towards the shell apex. The

penultimate and body whorls are cylindrical and occupy just under two thirds of the shell height. The surface of the shell has distinct fine ribbing with 9 ribs per mm on the body whorl (closer on the upper whorls). The protoconch and first whorl are smooth. The aperture is rounded. The peristome is continuous, but not strongly developed, with a callus continuing across the parietal wall. The lip is slightly reflected. There are eight or nine whitish apertural teeth. The curved angular tooth (upper parietal) emerges to the shell mouth where it is joined to the palatal wall by a strong callus. The end of the angular tooth is located opposite the gap between the supra-palatal and upper palatal teeth. The lower parietal tooth is not as tall as the angular tooth; it does not emerge onto the outer lip, but curves back and disappears from view inside the mouth. The supra-palatal tooth is small, nearly reaching the outer lip but not extending far back in the mouth. The upper palatal tooth is also small; it does not reach the outer lip, but extends further into the mouth. The lower palatal tooth is tall and strongly developed with its apex situated opposite that of the lower parietal tooth; it does not extend onto the outer lip, or very far down within the mouth. The well-developed basal tooth likewise does not extend to the outer lip or descend very far into the shell mouth. The upper columellar tooth is not always present; it is small, and often distinct, but rather deeply inserted under the parietal wall. The middle columellar tooth is well-developed; not extending to the outer lip but disappearing from view within the mouth. The lower columellar tooth is not always present; it is usually small and situated at the base of the columella deep within the mouth. The remaining shell colouration (present on some shells only) is a light brown or whitish background with two brown bands.

Measurements: Holotype height 2.5 mm, breadth 1.2 mm; Paratypes within the range 2.4–2.9 × 1.2–1.3 mm.

Derivatio nominis: From the name of *L. corneocostata* (Wollaston, 1878), the species it most closely resembles, with addition of *sub* meaning almost.

Comparisons: Generally similar to shells of the rather variable *L. corneocostata*, but it is considerably and consistently smaller (the smallest *L. corneocostata* we have measured is 3.1 × 1.4 mm). The lower columellar tooth is never present in shells of *L. corneocostata*. It is possible that *L. subcorneocostata* should be regarded as a subspecies of *L. corneocostata*, but in the absence of intermediate shells it seems best regarded as specifically distinct.

Type Locality: By track on NW side of valley c. 1 km NE of Porto da Morena, Porto Santo. Collected from calcarenite (at 1.5 m depth) underlying colluvium exposed in a bank beside the track.

Material examined: Besides the Holotype (lodged in the National Museum of Wales as NMWZ 1989.098.02) there are more than 50 paratypes (many of them immature or broken); one paratype is lodged in the collection of the British Museum (Natural History). This species was also found in samples from different stratigraphic levels within the calcarenite underlying the colluvium. It is present in similar deposits on the SE side of the valley approximately 200 m away. Two shells have also been found at Ponta de Canaveira on the SW coast of Porto Santo.

***Actinella (Faustella) morenensis* sp. nov. (Fig. 1, Plate 31 C)**

Description: The rather thick and strongly calcified shell has 5.5–6 whorls. The spire is raised, giving a domed-hemispherical outline. The body whorl has a sharp peripheral keel (sometimes with slight concavity just under the keel) and the sutures are shallow. The base

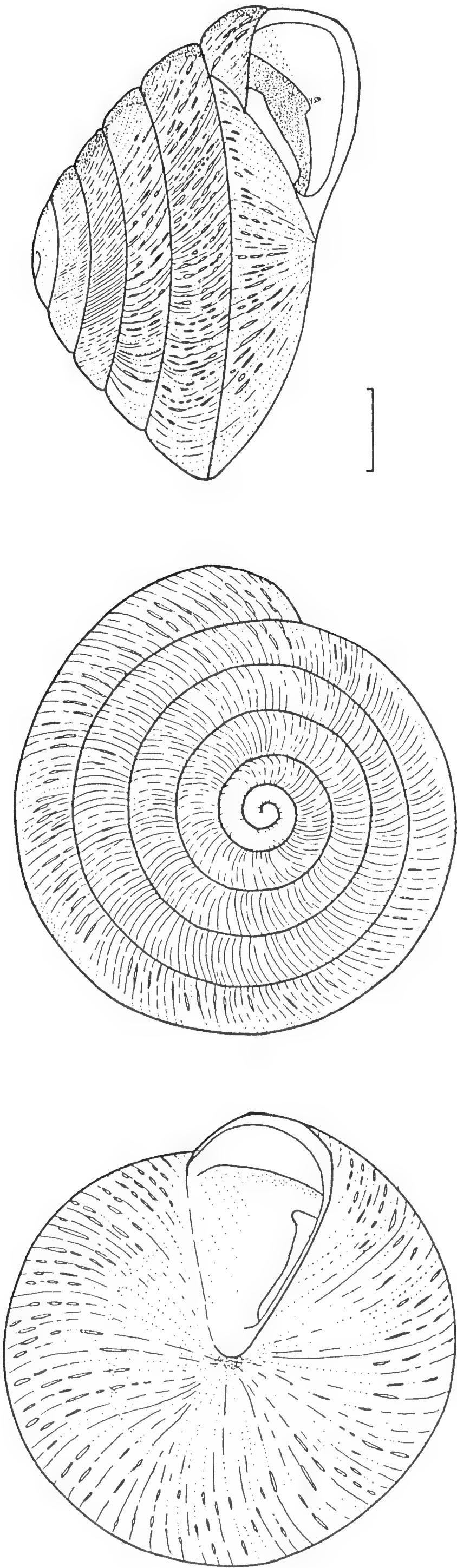


Fig. 1. *Actinella morenensis* sp. nov., Holotype NMWZ 1989.098.03; Scale bar 1.0 mm.

SEDDON: QUATERNARY SNAILS FROM PORTO SANTO

of the shell is somewhat flattened. The penultimate and body whorls occupy about two-thirds of the shell height. The umbilicus is completely closed. The protoconch is smooth. The first three whorls have slightly raised irregular transverse ribs. The last 2.5–3 whorls have sculpture consisting of variably developed, slightly elongate, upstanding tubercles along the transverse ribs and occasionally between the ribs giving a granostriate appearance. The ribs continue over the keel onto the underside of the shell; the tubercles becoming more elongate on the underside. The last tenth of the body-whorl is sharply downturned. The aperture is narrow and sub-triangular. The peristome is continued by a slight callus across the parietal wall. The lip is very slightly reflected. There is a transverse thickening forming a callus on the parietal wall. There is an area of pronounced thickening around the palatal wall extending back into the mouth to the point where the body-whorl inside the mouth turns down, thus constricting the opening. The columellar margin is also thickened, sometimes forming a long low tooth near the junction with the palatal margin. The fossil shells are white in colour.

Measurements: Holotype height 5.6 mm, breadth 4.0 mm; Paratypes 5.3–6.0 × 3.8–4.1 mm.

Derivatio nominis: Adjective based on the name Porto da Morena (the coastal region close to the type locality).

Type Locality: By track on NW side of valley c. 1 km NE of Porto da Morena, Porto Santo. Collected from the upper levels of the calcarenite (at 1.5 m depth) exposed in a bank beside the track.

Material examined: Besides the Holotype (lodged in the National Museum of Wales as NMWZ 1989.098.03) there are over 200 paratypes. One paratype is lodged in the collection of the British Museum (Natural History). This species was also found in samples from different stratigraphic levels within the calcarenite. It is present in similar deposits on the S.E. side of the valley approximately 200 m away.

Comparisons: The shell differs from *Actinella* (*Faustella*) *promontoriensis* Waldén, 1983 in having a more conical (less rounded) spire, shallower sutures and a sharper keel. In *A. promontoriensis* the blunt keel is placed higher on the body whorl and the underside of this whorl is deeply convex, whereas *A. morenensis* has the keel more centrally placed and the underside of the body whorl less deeply convex. The position of the parietal callus is very similar in these two species. The form of the palatal callus differs, as in *A. morenensis* it lacks what Waldén (1983) described as the 'subpalatal knot' at the end of the palatal callus of *A. promontoriensis*. Unlike many of the *Actinella* (*Faustella*) group of species from Madeira, *A. morenensis* lacks irregular spiral lines on the upper surface of the lower whorls and has the mouth less downturned. *A. fausta* (Lowe, 1831) differs in being less keeled, with a slightly deeper suture and having an abrupt end to the palatal callus; fresh shells of this species are hairy.

ACKNOWLEDGEMENTS

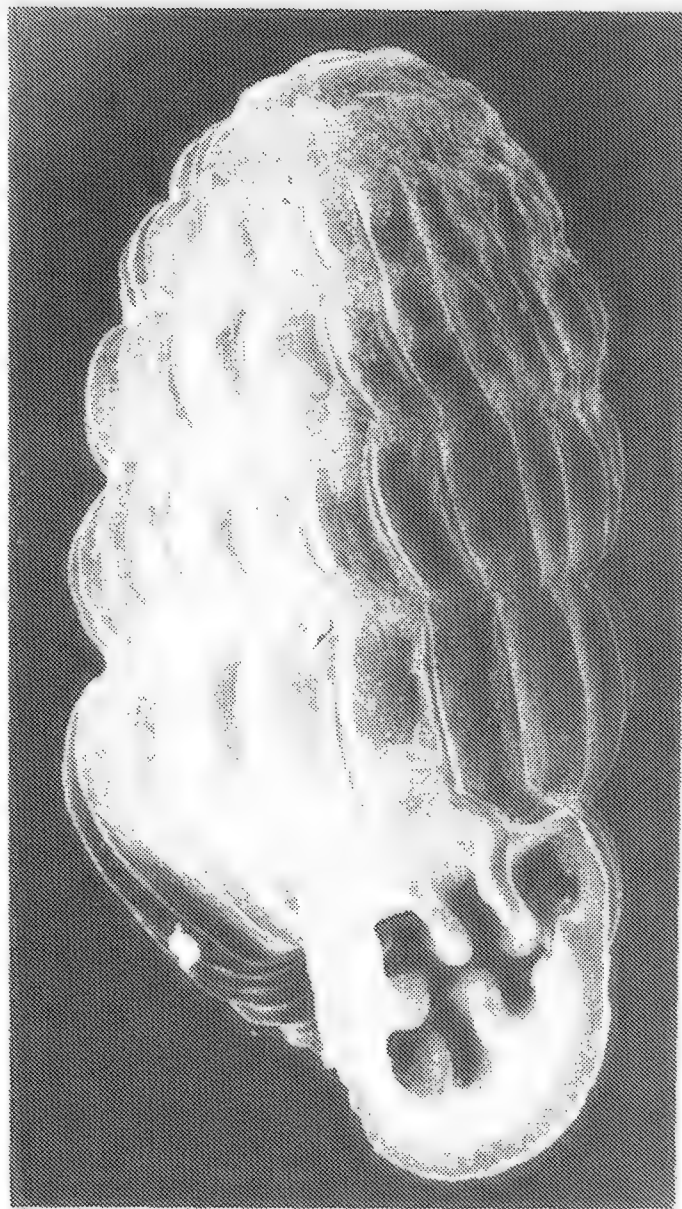
Thanks are due to Dr. B. Colville and Mr. A. Norris for assistance with fieldwork, Dr. D. T. Holyoak for helpful comments, Dr. P. G. Oliver for help in obtaining S.E.M. illustrations and the staffs of the Mollusca sections at the National Museum of Wales and the British Museum (Natural History) for access to specimens in their care. This study was carried out

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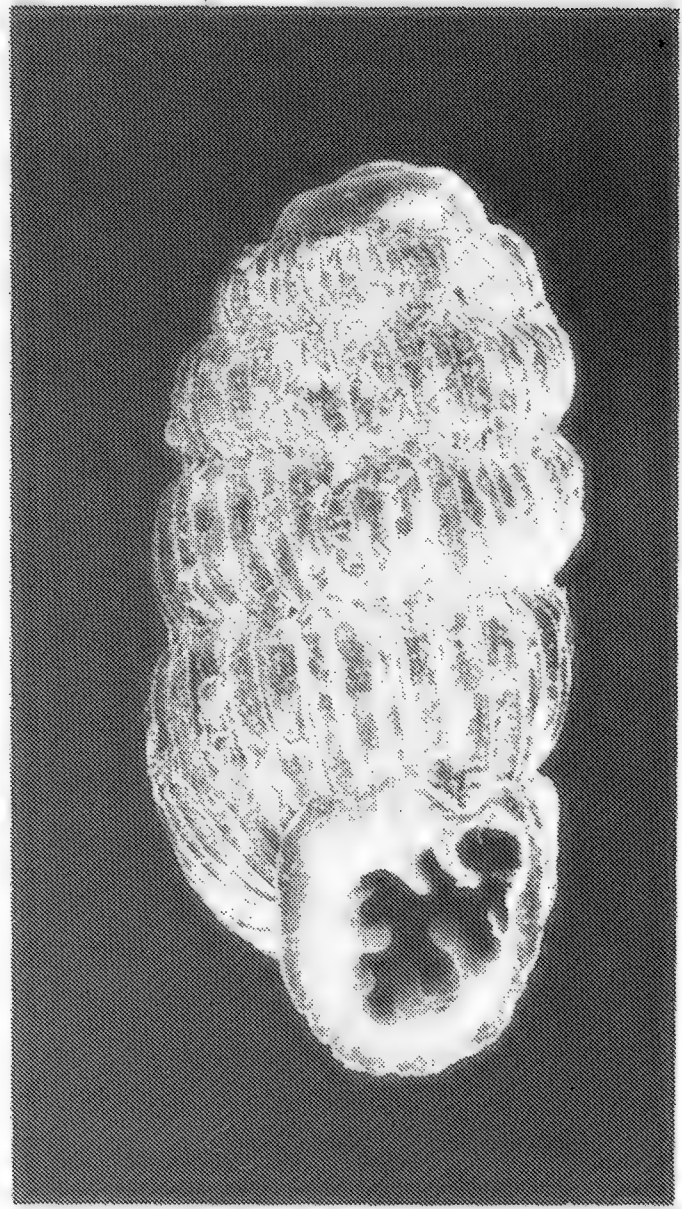
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A

B



C

PLATE 31

Scanning electron micrographs of shells of *Leiostyla* and *Actinella*.

A *Leiostyla espigaoensis* sp. nov. Holotype: NMWZ 1986.098.01;

B *Leiostyla subcorneocostata* sp. nov. Holotype: NMWZ 1986.098.02; scale bar for A and B 1.0 mm.

C *Actinella morenensis* sp. nov. Holotype: NMWZ 1986.098.03; apical view showing shell sculpture; scale bar 1.0 mm.

ON SOME SMALL WEST AFRICAN LAND SNAILS (GASTROPODA: PULMONATA)

A. J. DE WINTER¹

(Accepted for publication, 21st October 1989)

Abstract: Four species of small land snails, *Cecilioides manensis* n. sp. (Ferussaciidae), *Truncatellina silvicola* n. sp. (Vertiginidae), *Pupisoma* cf. *orcula* (Benson) (Valloniidae), and *Prositala butumbiana* (von Martens) (Endodontidae s.l.) are reported from western Côte d'Ivoire. The latter two are new records for the Côte d'Ivoire. The genus *Truncatellina* has never been recorded before from West Africa.

INTRODUCTION

Although a great deal of literature has been devoted to the West African land snail fauna, the area must malacologically still be considered poorly known. The total number of species described from West Africa (as delimited by Binder, 1981) is in the order of that existing in the western and central part of Europe, the latter area being smaller and having a much less diverse flora and fauna. A large proportion of these West African taxa apparently has not been found again since their original description. Compared to other parts of Africa, very few small species (i.e. shell length less than 4 mm) are known. It was therefore no great surprise to find in leaf-litter samples, collected from forests near Man, western Côte d'Ivoire, four representatives of genera previously unknown from this area, two of which proved to be undescribed. It was thought worthwhile publishing these records together, as all refer to members of families poor in species in this area, and do not require a major revision.

The abbreviations KBIN and RMNH are used to indicate the collections of the 'Koninklijk Belgisch Instituut voor Natuurwetenschappen' (Brussel), and the 'Rijksmuseum van Natuurlijke Historie' (Leiden), respectively.

SPECIES

Cecilioides manensis n. sp. (Figs. 1–2)

Material: Holotype (RMNH 56285): Côte d'Ivoire, about 5 km NW of Man, forest along river near water-fall ('La Cascade'); alt. 600 m; 4.I.1989; A. J. de Winter leg. Paratype (RMNH 56286): Côte d'Ivoire, Man, hill with forest remnants near hotel 'Les Cascades', under stones; alt. 375 m; A. J. de Winter leg.

Description: Shell minute, whitish-hyaline, transparent, glossy, without obvious sculpture, very slender (about 2.8 times as long as wide). Number of whorls slightly over 4, little convex, increasing somewhat irregularly. For shell measurements see Table 1. Height of last whorl about three quarters of total height. Apex obtuse. Columella concave, truncate at base, in the holotype with a distinct notch. Aperture pyriform, about 2.5 times as high as wide. Apertural height slightly less than half the total height. Peristome expanded, strongly arching forward, with a callose outer thickening.

¹c/o Rijksmuseum van Natuurlijke Historie, P.O. Box 9517, NL-2300 RA Leiden, the Netherlands.

TABLE 1

Shell measurements (in mm) of *Cecilioides manensis* n. sp., *Truncatellina silvicola* n. sp., and *Prositala butumbiana* (von Martens).

| | Height | Width | HLW | AH | AW | W |
|----------------------|--------|-------|------|------|------|-----|
| <i>C. manensis</i> | | | | | | |
| holotype | 2.06 | 0.75 | 1.58 | 0.97 | 0.39 | 4+ |
| paratype | 2.20 | 0.80 | 1.76 | 1.08 | 0.46 | 4+ |
| <i>T. silvicola</i> | | | | | | |
| Holotype | 1.64 | 0.80 | 0.75 | 0.51 | 0.49 | 6 |
| <i>P. butumbiana</i> | | | | | | |
| 1 | 4.12 | 4.66 | 2.70 | 1.89 | 2.37 | 6 |
| 2 | 4.60 | 5.07 | 2.84 | 2.10 | 2.64 | 6.4 |
| 3 | 4.66 | 5.27 | 2.91 | 2.16 | 2.84 | 6.4 |
| 4 | 4.15 | 4.80 | 2.84 | 2.08 | 2.43 | 6.2 |

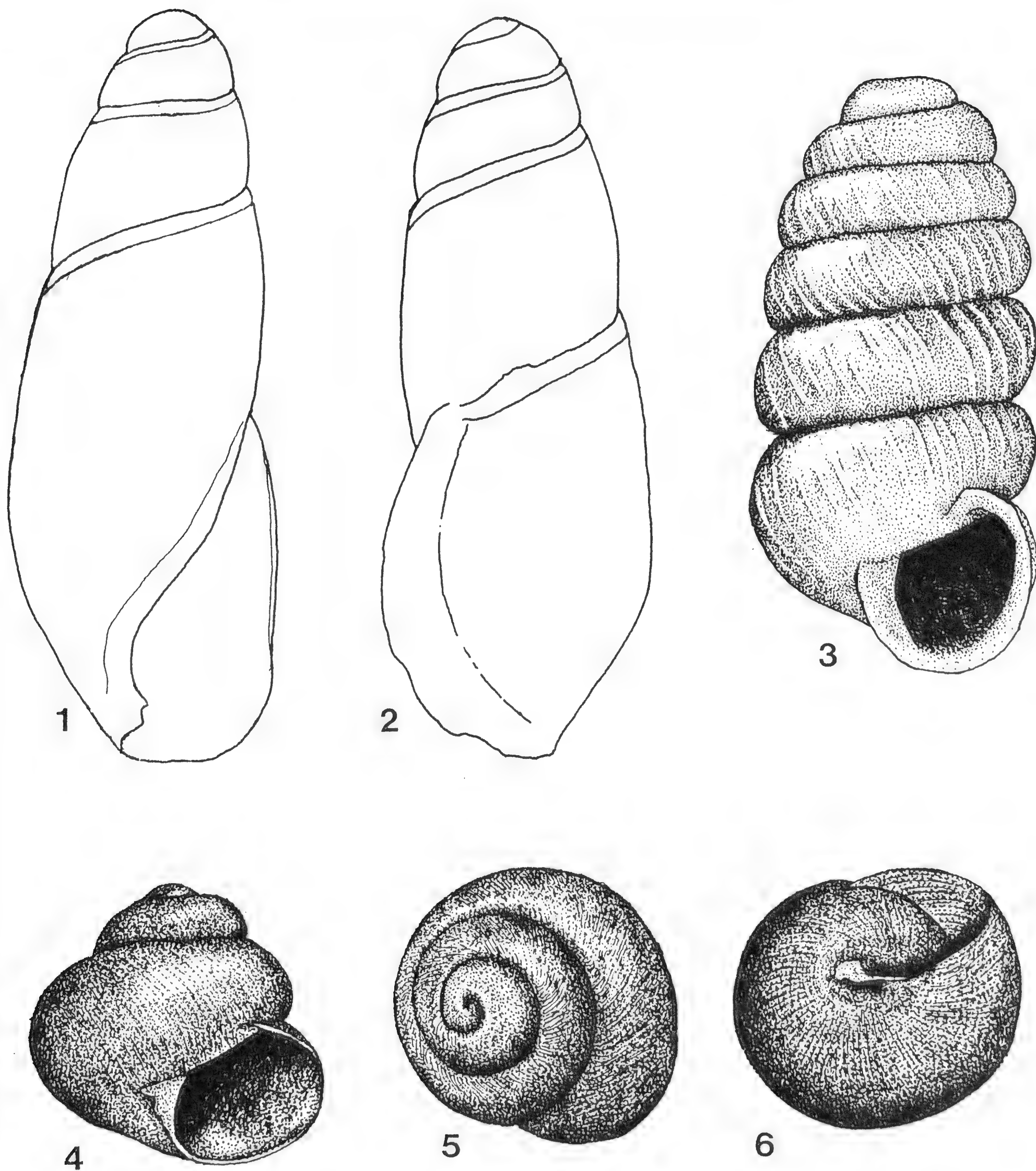
Measurements according to Adam 1954, p. 728, Fig. 1A. Whorl counting according to Gittenberger *et al.* 1984, p. 16, Fig. 4a. Abbreviations: HLW, height of last whorl; AH, apertural height; AW, apertural width; W, number of whorls.

Remarks: *Cecilioides manensis* appears to be the smallest African species described in the genus. Only two records of *Cecilioides* species are known from western Africa. Ortiz de Zarate Lopez & Ortiz de Zarate Rocandio (1959) reported a single shell from Fernando Poo, which they identified with *C. iota* (Adams, 1845), a species described from Jamaica. From the dimensions and figure provided, it seems quite possible that this specimen is conspecific with *C. manensis*. Judging from Pilsbry's (1909) description and figures, *C. iota* from Jamaica indeed seems close, but appears to differ in its relatively smaller apertural height, which constitutes only 0.38–0.40 of the total shell length. The fact that *C. iota* is only known from Jamaica (Pilsbry 1909) also makes it unlikely that it is conspecific with the species here described. Of *C. kalawangaensis* Darteville & Venmans, 1951, described from near Matadi, western Zaire, some paratypes (in RMNH) were studied. These have a decidedly more slender shell, which is well over three times as long as wide, with about half a whorl more at the same size, as well as a more acute apex. *C. virgo* (Preston) from Naivasha, Kenya is 2.5 mm long, but much more slender (Preston, 1911, p. 220, Pl. XI, fig. 7). All other African species described are over 3 mm long, and appear to differ in relative shell dimensions. On the other hand, *Cecilioides* species are known to be notoriously variable. Nevertheless, in view of the fact that the Ivory Coast locality is far removed from that of all other African *Cecilioides* species known, it seems preferable to give the species a name of its own to draw attention to its existence. Apart from the already mentioned localities the genus *Cecilioides* in tropical Africa is known from Ethiopia (Pilsbry 1909), Kenya, Uganda (Verdcourt 1983a), Malawi (Van Bruggen & Meredith 1984), Zimbabwe, Namibia, Botswana, Zambia, Mozambique, South Africa (Connolly 1939, Van Bruggen 1970), and Madagascar (Van Bruggen 1980).

Truncatellina silvicola n. sp. (Fig. 3)

Material: Holotype (RMNH 56287): Côte d'Ivoire, about 5 km NW of Man, forest along river near water-fall ('La Cascade'); alt. 600 m; 4-I-1989; A. J. de Winter leg.

Description: Shell minute, elongate cylindrical, pale brown. Height slightly less than twice the width. Last whorl less than half the total height. There are 6 rather convex whorls. Sculpture consists of widely spaced, more or less regular, superficial radial ribs on all but the first 1¼



Figs. 1–2. *Cecilioides manensis* n. sp., different views of holotype shell (RMNH). Actual height 2.06 mm.

Fig. 3. *Truncatellina silvicola* n. sp., holotype shell (RMNH). Actual height 1.64 mm.

Figs. 4–6. *Pupisoma* cf. *orcula* (Benson), different views of shell from Man, Côte d'Ivoire. Actual height 1.48 mm.

whorls. For shell measurements see Table 1. Aperture rounded, about as long as wide, without any folds or denticles.

Remarks: *T. silvicola* differs from most African species by its widely spaced radial ribs. Comparison with type material from the KBIN showed that *T. upembae* Adam, 1954, from eastern Zaire is generally less slender, with shallower sutures and more regular, closer set radial ribs. The same holds for *T. naivashaensis* (Preston, 1911) from Kenya, which originally

was described as edentate, but the types proved to have a columellar fold visible when obliquely viewed (Adam 1954). *T. ruwenzoriensis* Adam, 1957 differs in being somewhat larger and wider, as well as by having radial sculpture confined to the upper post-apical whorls (Adam, 1957). Hitherto the genus *Truncatellina* was only known from South and East Africa: South Africa, Ethiopia, Uganda, Kenya, Tanzania, Zaire (Adam 1952, 1957), and Malawi (Van Bruggen & Meredith 1984).

Pupisoma* cf. *orcula (Benson, 1850) (Figs. 4–6)

Material: Côte d'Ivoire, about 5 km NW of Man, forest along river near water-fall ('La Cascade'); alt. 600 m; 4-I-1989; A. J. de Winter leg. (RMNH/1).

Remarks: Only one fresh shell was found. It measures 1.48 mm in height and 1.54 mm in width, with 3 whorls. I compared it with specimens reported from eastern Zaire by Adam (1954, 1957) (in KBIN), from which it differs by a darker brown colour, a somewhat wider umbilicus, and by a weaker spiral sculpture on the ventral side of the shell; on the upper side spiral striae are hardly visible, whereas in the Zairean specimens this feature is more prominent. I also have the impression that it differs somewhat in microsculpture on the apical whorls, but in order to verify this more material is needed to undertake S.E.M. studies. For these reasons, and because no material from India was studied, I am somewhat hesitant to identify it with *P. orcula*. Originally described from India, *P. orcula* has been reported from a vast area: Japan, Philippines, Java, Borneo, Zimbabwe, South Africa, Zaire, Mauritius (Adam 1954, 1945, Thompson & Dance 1983), Kenya (Verdcourt 1983a), and Malawi (Van Bruggen & Meredith 1984). Only recently the species was found in eastern Nigeria (Verdcourt 1987). To my knowledge the present record is the westernmost locality known.

There can be little doubt that in view of the relatively undisturbed forest habitat it was found in, *P. cf. orcula* is an autochthonous element of the West African fauna. The genus *Pupisoma* is probably quite old. A fossil species is known from the upper Miocene from southern Germany (Falkner 1974). The genus inhabits the tropical and subtropical regions of all continents. Falkner (1974, p. 236) suspects the African localities to be due to recent introductions by man. In my opinion, *P. orcula* is more likely a world-wide natural inhabitant of (sub)tropical forests, very often overlooked because of its minute size.

Prositala* *butumbiana (von Martens, 1895)

Material: Côte d'Ivoire, recently burned down primary rainforest about 10 km ESE of Tai, along tracks to entrance of Parc National de Tai, 6 km NE from road Guiglo-Tabou; alt. 160 m; April 1988; G. Schmelzer leg. (RMNH/10).

Remarks: For measurements of four adult shells see Table 1. The shells are somewhat bleached, but some still possess parts of the characteristically sculptured periostracum. In all respects they match the careful description by Verdcourt (1983b), who showed *Prositala fernandopoensis* Germain to be a synonym of von Martens' species from Uganda. Until now, it was known from Sierra Leone, Fernando Poo, Cameroun, Uganda, and Kenya. The present record is the first from the Côte d'Ivoire.

Another likely candidate to sink into the synonymy of von Martens' *P. butumbiana* is *Philalanka camerunensis* Thiele, 1931 from Buea, Cameroun. According to Thiele's (1931, p. 400) own assertion, this species is very close ('sehr ähnlich') to *P. fernandopoensis*, and from Thiele's description and figure there seems no reason to separate them. Of course the unique holotype needs to be studied to be certain of this. It is not certain if it still exists, as the author states that it was accidentally broken.

ACKNOWLEDGEMENTS

Thanks are due to Dr. T. Backeljau (Koninklijk Belgisch Instituut voor Natuurwetenschappen, Brussel) for providing material for comparison, to Dr. A. C. van Bruggen (Leiden) for helpful discussions and commenting on the manuscript, and to Miss Gaby Schmelzer (Wageningen) for providing me with several interesting West African land snail samples, one of which was used in this study.

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REVIEW

Saudi Arabian Seashells. By D. P. Sharabati. Kegan Paul International, London, 117 pp., 70 colour plates, numerous text figures, one map. 1988. ISBN 07103 0051 4. £25.00.

Shells and shell collecting fascinate a large number of scientists and many laymen who find joy in collecting and arranging these attractive seashore objects. There is certainly a great deal of excitement in the anticipation of discovering a shell new to one's collection or even new to science.

Recently a large number of books have been published on identification of sea shells found in various geographical areas of the world. Much attention has been given to the seashells of the Indo-Pacific region, but few books have adequately illustrated and described the shells found in the Arabian Gulf. *Saudi Arabian Seashells* solves this problem. The book contains three major sections in addition to the foreword, preface, acknowledgement, glossary and bibliography. The foreword is by Dr. R. Tucker Abbott the leading scientist in conchology of the world. His acceptance to foreword this book is a good indication for the high standard of this publication.

Doreen Sharabati has attempted to introduce the beauty of the marine molluscs to the layman. She indulges in describing the different methods of shell identification, mentioning both scientific and common names. She also explains the way they live.

A geographical description for the area is given in the first section which includes Saudi Arabia, The Red Sea and The Arabian Gulf. This concise geographical description for the area gives a clear picture to the reader about the zoogeographical relationships that may be found between the fauna of the two indented seas of the Indo-Pacific province (Red Sea & The Arabian Gulf).

In the second section the author starts to tell the story of the seashells through their general biology and classification and several other biological topics. This section as a whole contains important information to the people of the area, many of whom have never experienced such a natural history lesson before. The way this section is written expresses the great ability of the author to explain science to the general public. In the third section the author is more careful in dealing with the pure scientific material and the way of presenting it. She starts by explaining the Arabian habitats which include most of the seashore habitats and what species of shells live in each zone. After that she touches on the species of molluscs in the Red Sea and compares them with those found in the Arabian Gulf. At this point, I should express my admiration to the author for her excellent scientific description of the species which is unexpected from a non marine biologist.

The photographs presented in this book are marvellous and I congratulate the photographer for his great talent in photography especially for the full page colour plates. I am sure that such a book will open a new era of seashell collecting in the Arab world and will encourage more people to go to the sea shore to look out for shells and to admire their beauty as the author did.

LAITH A. J. AL HASSAN

CONCHOLOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND, PROCEEDINGS

TREASURER'S REPORT, 1987

This report is unfortunately very belated, due originally to trouble with our bank's accounting system and afterwards to the serious illness of the Treasurer.

It is difficult to compare the figures with those of the previous year, since Members' and Subscribers' rates were increased, and the increase also affected the amount received from covenanted subscriptions, which produced the very useful sum of £408.86. The Society is grateful to the Members who pay their subscriptions in this way, and would be glad if others would consider doing this.

There was a profit of £999.51 on the year. Donations were very similar to the previous year's; income from sales and investments rose slightly.

Printing costs continue to rise, also the hire of the room for meetings. Officers' expenses appear very high, but some expenses were claimed in arrears.

£800 5½% London County Council Loan matured, with a capital gain of £30.80.

20 Ordinary Members and 3 Junior Members are in arrears with 1986 subscriptions, and several Members have still omitted to amend bankers' orders to comply with the new subscription rates.

MARJORIE FOGAN
(Hon. Treasurer)

TREASURER'S REPORT, 1988

This year the accounts show a loss of £424.30, almost entirely attributable to printing costs. These included the index for Vol. 32 of the *Journal of Conchology* and the covers for Vol. 33, together with the production of the complete Members' list instead of the short list of amendments issued in 1987.

There was an increase in Members' and Subscribers' payments, and in receipts from covenanted subscriptions. Donations show a substantial increase. The amount produced by sales was very similar, but this was largely due to the sale of the Society's postcards. Through the good offices of Mrs. Light it was possible to order these at an advantageous price, and with Mr. Rands' excellent photograph these are proving popular and profitable.

£10,000 was withdrawn from the Post Office Investment account, and invested in National Savings Income Bonds.

In view of rising costs it is necessary to recommend an increase in the subscription for 1990.

27 Ordinary Members and 5 Junior Members are in arrears with 1987 subscriptions. As only 2 Junior Members are currently paid-up it appears that this section of the Society may no longer be viable.

Some Members have still not up-dated bankers' orders. Will all Members please take note of new rates and arrange to pay accordingly.

The bank is now charging a minimum of £5 for changing foreign cheques. It would be appreciated if overseas Members would pay in £ sterling; if unable to arrange this they should adjust remittances to allow for this.

MARJORIE FOGAN
(Hon. Treasurer)

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st DECEMBER 1987

[illegible]

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st DECEMBER 1988

| | | PROCEEDINGS | |
|---|----------|-------------|------------|
| | £ | £ | £ |
| Publications:- | | | |
| Newsletter | 3,795.60 | | |
| Journal:- | | | |
| Index for Volume 32 | 397.00 | | |
| Covers for Volume 33 | 765.00 | | |
| Volume 33, No. 1 | 2,537.77 | | |
| Volume 33, No. 2 | 2,946.23 | | |
| | | | 9,433.75 |
| Members' List | | | |
| | 6,646.00 | | 240.59 |
| Printing, Stationery and Postage | | | |
| Officers' Expenses | | 141.79 | |
| Meetings | | 51.50 | |
| Subscriptions | | 6.00 | |
| Bank Charges | | 12.50 | |
| Postcards | | 7.30 | |
| | | 17.00 | |
| | | 8.00 | |
| | | 142.36 | |
| | | | 386.45 |
| | | | |
| | | | 10.00 |
| Investment Income:- | | | |
| General Account | | 2,140.07 | |
| Life Members' Fund | | 365.74 | |
| Reserve and Research Fund | | 443.72 | |
| | | | |
| | | 2,949.53 | |
| Transfer to Reserve and Research Fund | | 443.72 | |
| | | | 2,505.81 |
| | | | |
| | | | £12,576.60 |

COMMUNICATIONS

A FURTHER SITE FOR *ARCULUS SYKESI* (CHASTER)

The Erycinacea is a group of small bivalves comprising twelve species in British waters. Of these, *Arculus* (*Neolepton*) *sykesi* (Chaster, 1895) is probably the rarest species with only a handful of mostly dead shell records since Chaster's description. A note on the most recent discovery from Guernsey, and a review of all previous records and some excellent drawings are given by Phorson *J. Conch. Lond.* **33** (1988) p. 106 and *Conchol. Newsletter* no. 106 (1988) p. 117).

In August 1989 about half a litre of lignitic shellsand was collected at low water mark near Shippards Chine, Compton Bay, Isle of Wight. Subsequent sorting of this sample yielded forty species of marine molluscs amongst which were 24 valves of *A. sykesi*. The Isle of Wight site represents a range extension to the hitherto disjunct localities recorded: Channel Islands, Cornwall and West Ireland and it was considered particularly important to seek confirmation of our identification. In this connection we are grateful to C. P. Palmer, J. E. Phorson, A. J. Rundle and S. M. Smith, all of whom have examined our material.

The shellsand sample was collected from a flat sandy stretch of Compton Bay about half a kilometre wide. To the northwest lie chalk cliffs and a rocky shore and to the southeast, reefs of Wealden marl. Whilst it is accepted that dead shells may be carried long distances before being deposited on the shore, it is worth noting that all except one of the species in the sample have been recorded alive by us on adjacent shores or immediately offshore since September 1987. As the shells are so small (<1 mm) and extremely fragile it is our view that dead shells of *Arculus* would not be transported very far before destruction.¹

The erycinaceans are characterized by their epifaunal mode of living. They attach themselves by a single byssal thread to other invertebrates to which they have become commensally associated—echinoderms, crustaceans and worms for example. To date nothing is known on the biology of *A. sykesi*, however it is reasonable to assume that its habit is similar to that of the other erycinaceans. In view of the large number of specimens found in such a small sample we feel that *A. sykesi* must be living off the south west coast of the Isle of Wight.

JANICE M. LIGHT² and IAN J. KILLEEN
²88 Peperharow Road, Godalming, Surrey, GU7 2PN
(Received 16th December, 1989)

¹Since writing this communication we have found very fresh specimens of *A. sykesii* with the ligament intact.

OBSERVATIONS ON *OTINA OVATA* (BROWN): A LITTLE KNOWN PULMONATE

There are four species of upper shore marine pulmonate in Britain; two of these (*Ovatella myosotis* and *Leucophytia bidentata*) being much more familiar than the others, *Onchidella celtica* and *Otina ovata*. The habitat for all these animals is specific and somewhat cryptic (see Morton, J. E. *J. Mar. biol. Ass. UK.* **33** (1954) pp. 187–224) and records for the smallest species, *O. ovata*, (an upper shore crevice dweller) are as elusive as the animal itself.

As with other very small species, one reason for the paucity of *Otina ovata* records may be the fact that the animal is overlooked. In addition, since the pulmonate quartet do not fit tidily into either marine or non-marine systematics they are not included in the recent Synopses or field guides and they may, therefore, be unfamiliar. The only major account on the morphology of *Otina* is given by Morton (*J. Mar. biol. Ass. UK.* **34** (1955) pp. 113–150). Furthermore, the animals are very difficult to find.

The geographical distribution of *Otina ovata* is rather restricted, being a British and northwest European species only. The majority of the records are from the Normandy and Brittany coasts of France and southwest England. The animal extends to south Wales and a scattering of sites around the Irish and western British coasts (although few of the Irish records are recent). The most easterly record of live specimens is from Portland, Dorset. In addition there was a dead shell record from the Isle of Wight. Our survey work has recently upgraded this record to live status.

In his *Guide to the Natural History of the Isle of Wight*, F. Morey (1909) records several specimens amongst shell sand at Brook. In August 1989 a sample of shellsand collected by us from Compton Bay, 2 km northwest of Brook also yielded a number of shells of *Otina ovata*. In an attempt to locate living material the site was revisited in September 1989.

The cliffs along this part of the Island's coast are composed of marls, silts and sandstones of the Wealden Beds which are subject to much erosion. The nature and instability of these cliffs did not appear suitable for *Otina* and no specimens were found. We then transferred our search to the nearest rocky cliffs, at Freshwater Bay, some 3 km to

the northwest. This is a small bay flanked by sheer cliffs of Upper Chalk containing many bands of flints. Weathering of the chalk has caused the formation of stacks and caves with a large number of crevices, and it was here that *Otina* was found living.

The tide had reached its lowest point and consequently the cliffs and upper shore had been exposed for at least 5 hours. Around HWM on the eastern side of the bay enormous numbers of *Littorina neritoides* and *L. saxatilis* were seen crawling on the open rock faces. Close inspection revealed areas where small groups of up to 20 *Otina* were also crawling openly on the chalk. It was noted that the *Otina* colonies coincided with the presence of a gelatinous blue-green algae in the openings of the crevices. This was subsequently identified by Dr. Bill Farnham as *Lyngbya martensiana*. In addition the chalk was colonized by a surface film of microscopic green algae. Although *Patella vulgata* was quite frequent at the site there were no barnacles, yet the ecological relationship between *Otina* and *Chthalamus stellatus* has been reported as being very close (Morton 1955 *op. cit.*). A search in similar habitats on the western side of the bay yielded further specimens, although the animal was less frequent. Although *Otina* is described as having a dark chestnut brown shell, colonies of white shelled forms were also found on both sides of the bay.

A second visit to the site was made 2 months later. The tide was receding but still about 3 hours away from full ebb. A careful search only yielded 2 specimens of *Otina* which could be seen within their crevices (*ca* 10 cm from the opening) from where they appeared to be emerging.

We feel that weather conditions may be an important factor in the ability to find *Otina* crawling in the open. On the first occasion the day was mild with continuous drizzle whereas on the second visit it was clear and sunny. This conforms with observations of the Portland colony where animals have only been seen 'crawling about under still, humid, dull drizzly conditions' (Dennis Seaward *pers. comm.*). Another factor could be the state of the tide. There may be a long interval after the sea has uncovered the upper littoral zone before the animals emerge from their crevices.

It seems that Marshall (*J. Conch. Lond.* **14** (1913) p. 69) hit the nail on the head when he wrote '*Otina* hunting is a thing emphatically to be learnt'.

We are grateful to Mrs. Stella Turk and Mr. Dennis Seaward for providing helpful information.

IAN J. KILLEEN¹ and JANICE M. LIGHT
¹163 High Road West, Felixstowe, IP11 9BD
 (Received 22nd December, 1989)

ADDITIONAL DATA ON THE FOOD OF THE NUDIBRANCH *DENDRONOTUS ROBUSTUS* FROM THE WHITE SEA

According to previous data *Dendronotus robustus* Verrill, 1870 feeds on campanularid hydroids, actinarians and sabellid polychaetes (Bergh, *Bull. Mus. Comp. Zool. Harvard*, **25** (1894), no. 10, pp. 125–233; Robilliard, *Can. J. Zool.*, **50** (1972), no. 4, pp. 421–432; Roginskaya, Ecological Investigations of the Shelf, P. P. Shirshov Institute of Oceanology USSR Academy of Sciences (1980), Moscow, pp. 80–84).

The present note gives an account of the gut content examination (by means of SEM) of a total of 12 specimens of *D. robustus* from Dvinsky Bay of the White Sea, dredged from 16–21 m depth, from sandy mud in July 1974.

New prey items for *D. robustus* were revealed. Besides the scanty hydroid remains, the diet consisted of numbers of fragmented specimens of Oweniid polychaetes (often swallowed together with their tubes), of beetle fragments and of amorphous semidigested material usually enclosing various diatoms (centric and pennate) and pollen grains. Semidigested Oweniid polychaetes dominated in 9 individuals out of 12. Beetle remains (fragments of elytra, heads, compound eyes, legs etc.), were found (together with some Oweniid polychaetes) in the stomach and gut of a single engorged specimen.

The contribution to the diet of diatoms and pollen is probably negligible.

I. S. ROGINSKAYA. P. P. Shirshov Institute of Oceanology of the Academy of Sciences of the USSR.
 Krasikova str. 23, Moscow, 117–218, USSR.
 (Received 10th October, 1989)

LEPTOCHITON SCABRIDUS (JEFFREYS, 1880) – A LIVE RECORD FROM COUNTY DONEGAL, IRELAND

During a Conchological Society field trip to Co. Donegal, 6 sites were visited by the main group between the 1st and 4th of June 1989. All sites yielded impressive lists of marine molluscs and one locality in particular, Broad Water, was notable in its representation of the chitons, with 6 of the twelve species on the British Isles list being recorded alive. At this site, all three species of the genus *Leptochiton* were found alive. The site is an extremely sheltered, gently

COMMUNICATIONS

sloping, rocky shore. On extreme low water spring tides there is evidence of the subtidal emergence phenomenon and the substratum of sand, gravel and shell debris with embedded rocks and boulder extends into the sub-littoral. At certain times during the tidal cycle the area experiences very fast flowing tidal currents creating a rapids effect.

Chitons were collected for later identification in the improvised laboratory at our rented accommodation. Of the *Leptochiton* specimens, the majority were found to be *Leptochiton asellus* (Gmelin, 1791), a smaller but significant proportion being *Leptochiton cancellatus* (Sowerby 11, 1840). A small number of specimens were identified by J.M.B. as *Leptochiton scabridus*. *L. scabridus* is a rather small chiton, elongate oval in shape with a narrow girdle and diagnostic valve sculpturing. In the live animal the foot is a characteristic bright red in colour; this is a particularly useful field identification character.

L. asellus is common from around low water mark extending to a depth of 250m., living on silty-stony bottoms often attached to shell debris. It has a wide distribution and is found commonly off the entire coast of the British Isles. *L. cancellatus* is not nearly as common and occurs from around extreme low water mark to depths of 900m., favouring attachment to small stones or shell debris on silty-stony bottoms. It is found around the British Isles. *L. scabridus* is rare with a very restricted distribution, previous records showing it confined to the south-west coast of England, the Channel Islands and the coast of Brittany. The south-west England records are pre 1951 only, but specimens have been found in the Channel Islands as recently as 1985 by J.M.B.

A feature of the preferred habitat of *L. scabridus* is that it is often found attached to stones and pebbles that are heavily embedded in clean sand to a depth of 15–20cm. Many of the rocks which were disturbed during the work at Broad Water were embedded in this manner. It is interesting to note that the substratum at the Broad Water site was sufficiently diverse to accommodate all three species of *Leptochiton* – a hitherto unusual occurrence.

The site does not have conservation status and it is a fragile ecosystem. There is always the possibility of disruption to the habitat with a consequent adverse effect on the chiton population. The lifting of deeply embedded rocks and boulders may result in animals being detached. In favourable conditions chitons may easily re-attach, but if the animals become buried in the turmoil of sand and gravel, re-attachment may not occur.

It is proposed to revisit the site in 1990 when it is intended that a more detailed study of the *Leptochiton* populations will be carried out.

JANICE M. LIGHT

88 Peperharow Road Godalming, Surrey, England GU7 PN

JOHN M. BAXTER

Marine Biology Station, Queen's University Belfast, The Strand, Portaferry, Co. Down, Northern Ireland.

(Received 9th January, 1990)

INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

Applications published in the Bulletin of Zoological Nomenclature

The following applications were published on 29 September 1989 in Vol. 46, Part 3 of the *Bulletin of Zoological Nomenclature*. Comment or advice on these applications is invited for publication in the *Bulletin* and should be sent to the Executive Secretary, ICZN, British Museum (Natural History), Cromwell Road, London SW7 5BD, U.K.

Case 2682

Fryeria Gray, 1853 and *F. rueppelii* Bergh, 1869 (Mollusca, Gastropoda): proposed conservation.

D. J. Brunckhorst, Zoology Department, University of Queensland, St. Lucia, Queensland, Australia, 4067.
W. B. Rudman, The Australian Museum, P.O. Box A285, Sydney South, New South Wales, Australia, 2000.
R. C. Willan, Zoology Department, University of Queensland, St. Lucia, Queensland, Australia 4067.

Abstract. The purpose of this application is to conserve the generic name *Fryeria* Gray, 1853 and the specific name *rueppelii* Bergh, 1869 as the name of its type species, for a nudibranch gastropod, by suppression of the unused senior synonym *Fryeria pustulosa* Gray, 1853.

Opinions published in the Bulletin of Zoological Nomenclature

The following Opinions were published on 29 September 1989 in Vol. 46, Part 3 of the *Bulletin of Zoological Nomenclature*.

Opinion 1553

ATYIDAE De Haan, [1849] (Crustacea, Decapoda) and ATYIDAE Thiele, 1925 (Mollusca, Gastropoda): homonymy removed

INSTRUCTIONS TO AUTHORS

Manuscripts should be sent to:— **Dr D. T. Holyoak, School of Geography and Geology, The College of St. Paul and St. Mary, The Park, Cheltenham, Gloucester, GL50 2RH.**

PAPERS Two copies of text and illustrations should be submitted; one set of illustrations must be good quality originals. Authors should refer to recent copies of the *Journal* for a guide to format. Authors are reminded of the high cost of printing and therefore are expected to write concisely and to make maximum use of page size when designing art-work and tables.

COMMUNICATIONS These are intended to be short notes of an original nature which do not merit the treatment of a full paper. *Communications* must not contain any figures, tables or plates and should conform in style to that of recent issues of the *Journal*.

Proposed fourth edition of the International Code of Zoological Nomenclature – a call for possible amendments to the third (1985) edition

The International Commission on Zoological Nomenclature has embarked on the preparation of a new (fourth) edition of the Code and has established an Editorial Committee for that purpose. It is expected that publication will be in late 1994 or in 1995. A considerable number of possible amendments to the Code have been suggested and these will be examined by the Editorial Committee. The Commission invites the submission of further possible amendments to the current (1985) Code and these should be sent as soon as possible to the Executive Secretary, I.C.Z.N., British Museum (Natural History), Cromwell Road, London SW7 5BD, U.K. It is intended that proposals received by the end of 1989 will be discussed at meetings held in conjunction with the International Congress of Systematic and Evolutionary Biology (ICSEB) in Maryland in July, 1990.

Official Lists and Indexes of Names and Works in Zoology – Supplement

The *Official Lists and Indexes* was published in 1987. This gave all the names and works on which the International Commission on Zoological Nomenclature had ruled since it was set up in 1895 up to December 1985. There were about 9,900 entries. In the three years since 1985, 544 names and 3 works have been added to the *Official Lists and Indexes*. A supplement has been prepared giving these additional entries, together with some amendments to entries in the 1987 volume. This supplement can be obtained without charge from the following addresses, from which the *Official Lists and Indexes* can be ordered at the price shown:

The International Trust for Zoological Nomenclature, British Museum (Natural History), Cromwell Road, London SW7 5BD, U.K. – Price £60 or \$110

or

The American Association for Zoological Nomenclature, c/o NHB Stop 163, National Museum of Natural History, Washington DC 20560, U.S.A. – Price \$110 (\$100 to A.A.Z.N. members).

Journal of Conchology

Vol. 33, Part 5, May 1990

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NOTICE

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LIFE HISTORY OF *CARYCHIUM TRIDENTATUM* (RISSO, 1826) (GASTROPODA: PULMONATA: ELLOBIIDAE) IN THE LABORATORY

KATARZYNA BULMAN¹

(Accepted for publication, 20th October, 1990)

Abstract: The following data on the life history of *C. tridentatum* have been obtained based on 4 years of laboratory culture (235 individuals): a. eggs – laid singly, 1 to 8 per day, 1–13 per individual lifetime, 0.35–0.42 mm in diameter, with no calcareous shell; egg mortality c. 65%, b. incubation period 7–24 days, mean 14.2 days, c. mortality of juveniles c. 19%, d. time elapsing between hatching and maturity 37–129 days, e. time elapsing between hatching and first egg 56–166 days, depending on season. Four generations have been obtained as a result of uniparental reproduction.

INTRODUCTION

Papers on life history of *Carychium tridentatum* are few and pertain only to single aspects. Functional and morphological changes of the reproductive system in the annual cycle were described by Morton (1955a) based on histological studies. Some data on growth based on samples taken in the field in various seasons were given by Morton (1955b) and Doll (1982). The embryonic development and copulation were described by Doll (1979, 1982).

No precise data exist in the literature on the growth rate, while on the incubation, egg production per individual lifetime, life span and uniparental reproduction there is no information at all.

The aim of this paper is to present results of laboratory studies on those poorly known or unknown aspects of the life history of *C. tridentatum*.

MATERIALS AND METHODS

The laboratory culture was started on October 21st 1985. The observations lasted 4 years. Snails from populations in Wojcieszów nr. Jelenia Góra (Kaczawskie Mts, SW Poland), Bardo Śląskie nr. Kłodzko (Bardzkie Mts, SW Poland), Strążyska Valley (Tatra Mts, S Poland) and Trzebnickie Hills (SW Poland) constituted the material for laboratory culture. The material comprised a total of 235 individuals, including 53 collected in the field and 182 born in the laboratory. A total of 278 eggs laid in the laboratory were observed (182 hatched, accounting for the laboratory – born individuals).

The snails were kept in Petri dishes, of 6 cm diameter, with damp tissue paper as a substrate and leaf litter added as a source of food and substrate for egg-laying. The dishes were kept in plastic boxes with transparent covers as an additional protection against dessication. The temperature in the room ranged from c. 17°C in winter to c. 25°C in summer. The photo-period was not altered in any way. The humidity in the dishes was

¹ Museum of Natural History Wrocław University, Poland.

maintained at a constant level of *c.* 100%. The dishes were aired and watered at least twice a week, and new food added if and when necessary.

In order to observe growth and ability to reproduce uniparentally snails were placed in the dishes singly, at a very early development stage (as eggs or small juveniles). In some dishes groups of a few snails were kept together, as a source of eggs and to observe possible copulations.

Snails and eggs were measured using a calibrated eye-piece, with an accuracy of ± 0.025 mm. When measuring eggs, care was taken not to destroy the surface of the egg. In the case of juvenile snails over-heating or dessication were avoided. Whorls were counted according to Ehrmann's (1933) method.

Because of the large amount of material (see above), Tables 1–9 do not represent all the results; their purpose is to give representative examples. Most data in the tables are from observations in December because the results in that period were most numerous and best documented. October individuals were mostly brought from the field (hence 'birth date' unknown) while in spring field trips prevented me from daily observations.

RESULTS

Reproduction

In spite of numerous observations made during 4 years in all seasons and times of day, no copulation has been observed. For this reason all the data given below pertain to individuals reproducing uniparentally, and, likewise, to eggs produced uniparentally.

During the period of study four generations of uniparentally reproducing snails have been obtained (Fig. 1). Although no statistical comparison has been made, it seems that the reproductive ability in consecutive generations is not altered, and snails of all the generations laid eggs which developed normally.

The eggs are laid by individuals which have finished their growth and completed formation of apertural barriers. All the snails studied (235) laid their first eggs 56–166 days from hatching. The time interval between the shell completion and the first egg laid seems to depend on the season. Individuals hatched in autumn are the quickest to complete their shell growth and lay eggs fairly soon. In those hatched in spring the respective time intervals are longer (Fig. 1). Individuals hatched in winter grow to maturity quickly, but then lay their first eggs as late as the spring (Table 1). This results in three different life cycle patterns (Fig. 1), and exceptions are few (see Table 1).

The eggs are laid singly on a fragment of a rotting leaf or twig, sometimes also directly on the tissue paper; in the latter case always in close vicinity of some leaf-litter fragments which will later serve as food for the newly hatched young.

A freshly laid egg is slightly oval, completely transparent, gelatinous, covered only with a thin, elastic envelope containing no calcium carbonate crystals. The embryo at that stage occupies *c.* 1/100 egg volume, is spherical and yellow, situated centrally or somewhat eccentrically. The egg dimensions range from 0.35 mm to 0.42 mm and do not change during incubation. The egg is very large compared with adult snail (Fig. 2).

The eggs are not fastened to the substratum, they lie loose and each is covered with faeces of the parental individual. Eggs from which the faeces of the parental individual are removed, though bearing no trace of mechanical injury, fail to develop and die.

An individual lays from 1 to 8 eggs a day, and the total number of eggs produced per individual lifetime ranges from 1 to 13 (Table 2).

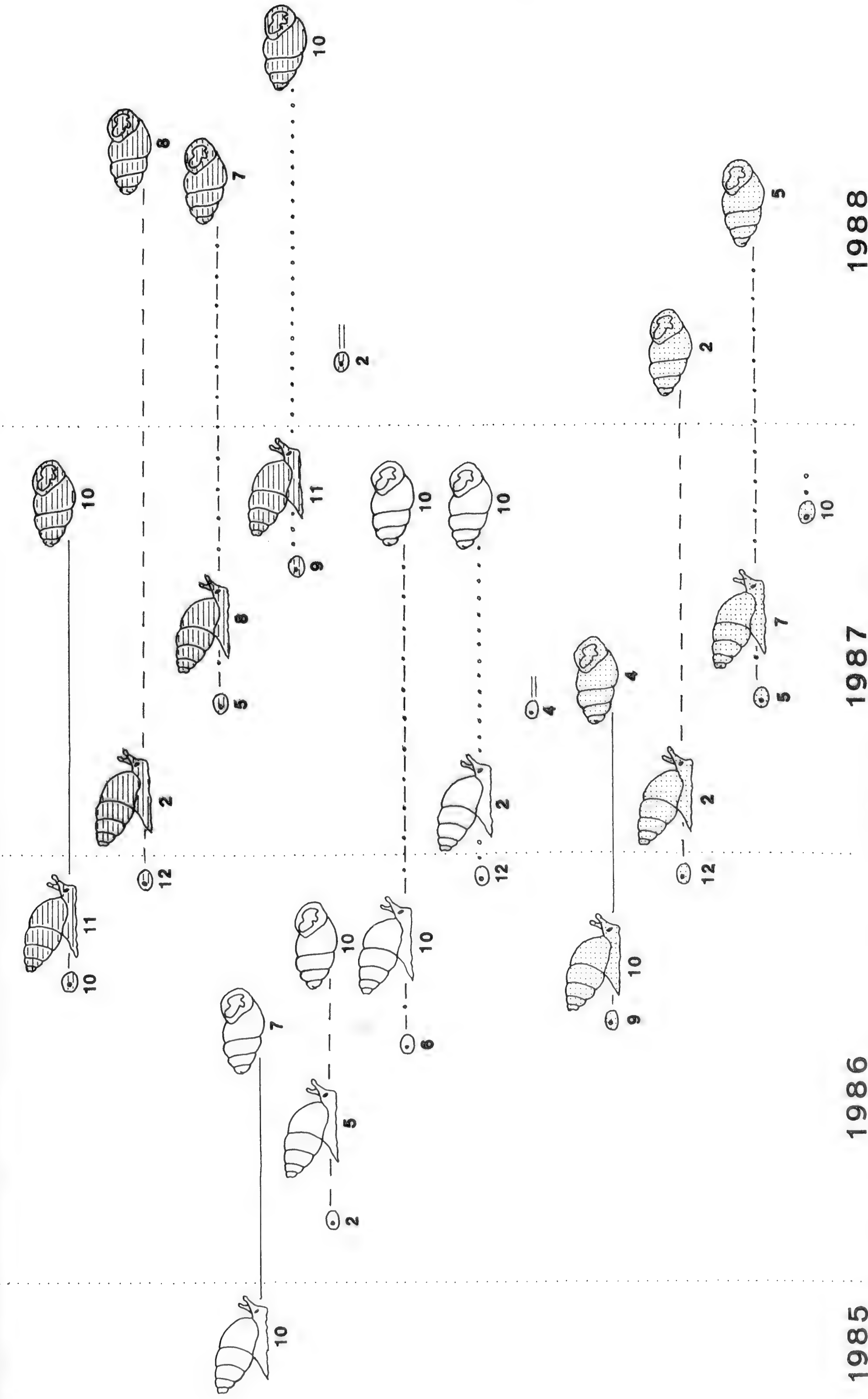


Fig. 1. Growth, maturation, egg laying and life span in three selected clones of *C. tridentatum*. The three clones are indicated by horizontal hatching, no hatching and dotted hatching. Consecutive generations in each clone are indicated as follows: — first, - - - second, - o - o - third, o o o fourth, === fifth. Numerals denote months, egg - beginning of individual life, crawling snail - maturity reached, empty shell - death.

TABLE 1

Time elapsing between hatching, shell completion and first egg

| Individual number | Hatching | Shell completion | First egg | Time elapsing between hatching and first egg (days) | Time elapsing between shell completion and first egg (days) |
|-------------------|---------------|------------------|--------------|---|---|
| 1. | 17 Dec. 1986 | 2 Feb. 1987 | 5 Mar. 1987 | 78 | 31 |
| 2. | 19 Dec. 1986 | 16 Jan. 1987 | 6 Mar. 1987 | 77 | 39 |
| 3. | 15 Dec. 1986 | 10 Feb. 1987 | 7 Apr. 1987 | 113 | 56 |
| 4. | 17 Dec. 1986 | 10 Feb. 1987 | 20 Mar. 1987 | 93 | 38 |
| 5. | 18 Dec. 1986 | 10 Feb. 1987 | 7 May 1987 | 140 | 86 |
| 6. | 15 Dec. 1986 | 2 Feb. 1987 | 30 May 1987 | 166 | 117 |
| 7. | 15 Dec. 1986 | 21 Jan. 1987 | 30 May 1987 | 166 | 129 |
| 8. | 16 Dec. 1986 | 2 Feb. 1987 | 7 Apr. 1987 | 112 | 64 |
| 9. | 15 Dec. 1986 | 21 Jan. 1987 | 30 May 1987 | 166 | 129 |
| 10. | 21 Dec. 1986 | 10 Feb. 1987 | 18 May 1987 | 148 | 97 |
| 11. | 23 Dec. 1986 | 2 Feb. 1987 | 30 May 1987 | 158 | 117 |
| 12. | 12 Dec. 1986 | 21 Jan. 1987 | 6 Apr. 1987 | 115 | 75 |
| 13. | 9 Dec. 1986 | 16 Feb. 1987 | 10 May 1987 | 152 | 83 |
| 14. | 31 Dec. 1986 | 10 Feb. 1987 | 7 Apr. 1987 | 97 | 56 |
| 15. | 19 Sept. 1986 | 27 Oct. 1986 | 16 Dec. 1986 | 88 | 50 |
| 16. | 12 Oct. 1986 | 6 Nov. 1986 | 7 Dec. 1986 | 56 | 31 |
| 17. | 12 Oct. 1986 | 7 Nov. 1986 | 13 Dec. 1986 | 62 | 36 |
| 18. | 12 Oct. 1986 | 22 Nov. 1986 | 12 Dec. 1986 | 61 | 20 |
| 19. | 15 Oct. 1986 | 27 Nov. 1986 | 18 Dec. 1986 | 64 | 21 |
| 20. | 1 Sept. 1986 | 1 Oct. 1986 | 15 Dec. 1986 | 105 | 75 |
| 21. | 28 Aug. 1986 | 14 Oct. 1986 | 15 Dec. 1986 | 109 | 62 |
| 22. | 28 Aug. 1986 | 15 Oct. 1986 | 12 Dec. 1986 | 106 | 58 |

Mean number of days elapsing between hatching and first egg for 1–14 (winter individuals): 127.21, SD=33.14; for 15–22 (autumn individuals): 81.38, SD=23.02
Mean number of days elapsing between shell completion and first egg for 1–14 (winter individuals): 79.79, SD=34.14; for 15–22 (autumn individuals): 44.13, SD=20.2

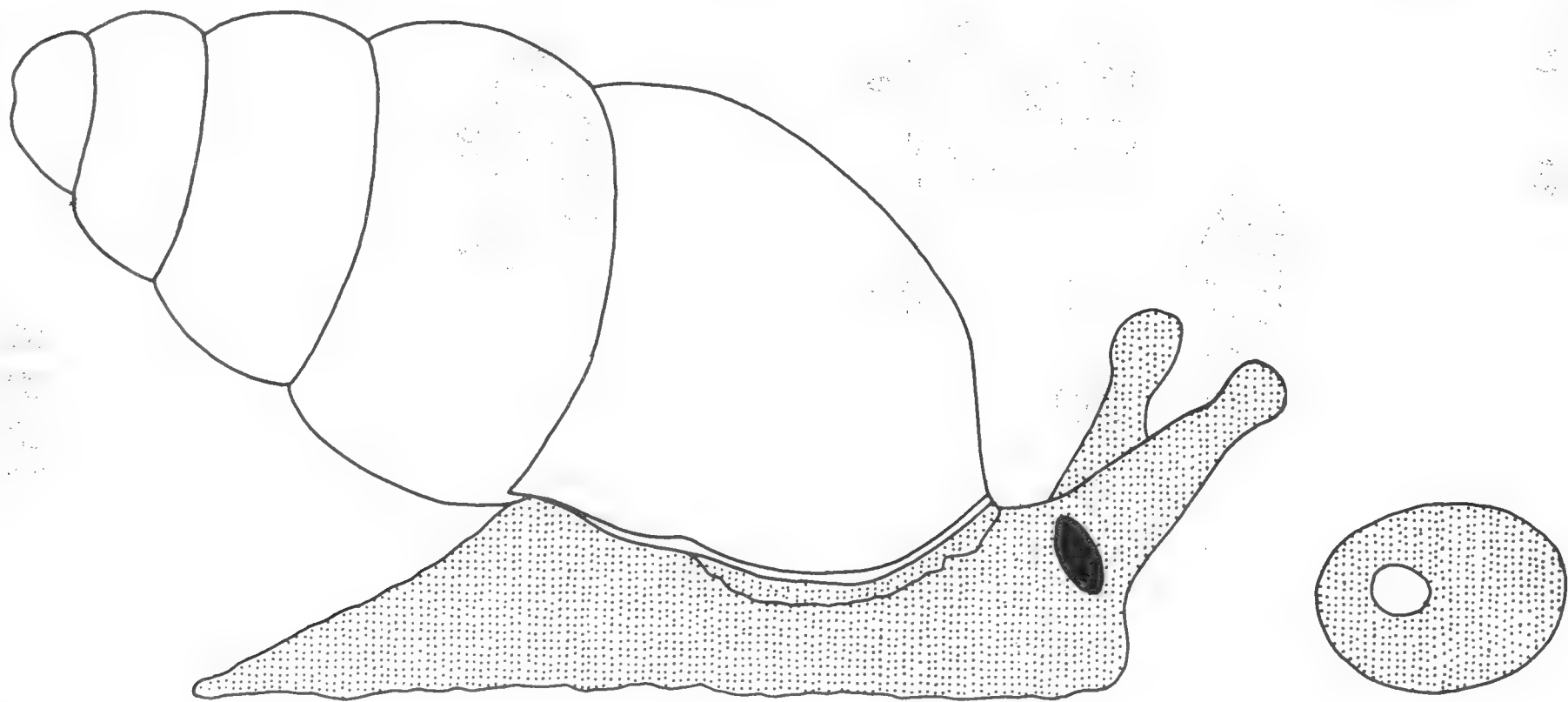


Fig. 2. Size comparison of an adult individual of *C. tridentatum* and its egg. (Diagrammatic).

TABLE 2

Life histories of selected individuals

| Individual number | Hatching | Shell completion | Total eggs | Death |
|-------------------|---------------|------------------|------------|---------------|
| 1. | 15 Dec. 1986 | 26 Jan. 1987 | 5 | 4 May 1988 |
| 2. | 18 Dec. 1986 | 10 Feb. 1986 | 10 | 27 Sept. 1987 |
| 3. | 19 Sept. 1986 | 27 Oct. 1986 | 10 | 17 Feb. 1987 |
| 4. | 16 Dec. 1986 | 2 Feb. 1987 | 9 | 6 Dec. 1987 |
| 5. | 12 Dec. 1986 | 2 Feb. 1987 | 5 | 6 Nov. 1987 |
| 6. | 21 Dec. 1986 | 10 Feb. 1987 | 8 | 12 July 1988 |
| 7. | 12 Dec. 1986 | 21 Jan. 1987 | 13 | 21 June 1988 |
| 8. | 6 Jan. 1987 | 10 Feb. 1987 | 5 | 30 May 1987 |
| 9. | 16 Dec. 1986 | 26 Jan. 1987 | 1 | 4 Nov. 1987 |
| 10. | 17 Dec. 1986 | 10 Feb. 1987 | 3 | 6 Nov. 1987 |

The mortality of eggs in the laboratory is 65.47% (of 278 eggs 182 hatched).

The eggs are laid in three periods: late autumn (October), winter (December), and spring (March to May). The intensity of egg-laying in these periods is approximately the same, though the data for some periods are still too scanty to enable a statistical comparison.

The mean incubation period is 14.2 days, the range being 7–24 days, depending probably on temperature (Table 3). During the first stage of incubation (on average the first 7 days) the embryo changes from intensely yellow and spherical to light yellow and irregular. In *c.* 10 days from the date of laying, the embryo is milky-white, irregular in outline and occupies nearly the entire egg volume. About 2 days before hatching the young snail is visible through the transparent envelope, with the embryonic shell from which the foot is partly extended, and its movements can be observed.

Hatching lasts a few hours.

A newly hatched juvenile has a protoconch of 1.25–1.75 whorl, and no sculpture visible under the stereomicroscope even at high magnification. A few to more than ten hours after hatching the juvenile snail feeds in the vicinity of its 'birth place'. Food includes egg envelopes and parental faeces. Then it starts feeding very intensely on bits of leaf-litter and its activity is almost constant during day and night.

The mortality of newly hatched snails is moderate and amounts to 19.2% (of 182 hatched snails 35 died during the early juvenile period).

Growth

Observations were made on 235 individuals of which 82 completed their shells, and the remaining ones died for various reasons (mainly accidental dessication) at various development stages.

The protoconch has 1.25–1.75 whorl, is *c.* 0.43 mm high and *c.* 0.31 mm broad. There are no apertural barriers. The adult shells range from 4.3 to 5.8 whorls, are *c.* 1.8 mm high and *c.* 0.85 mm broad, and have two teeth: parietal and columellar, in the aperture. Both those teeth appear at a very early growth stage, on the transition between the protoconch and the definitive shell. The columellar appears in a two-whorled shell as a small nodule in the lower part of the columellar wall. The parietal appears a little later, in shells of 2.5 whorls, as a slight convexity approximately in the middle of the parietal wall. With the growth of shell, the parts of those teeth situated deeper, i.e. further from the aperture and thus older, are gradually resorbed while new parts are added next to the aperture (Fig. 3).

Under the conditions of constant and favourable food and humidity given during laboratory culture the rate of shell growth and of formation of particular whorls varies

TABLE 3

| Egg number | Incubation period | | Incubation (days) |
|------------|-------------------|--------------|-------------------|
| | Laid | Hatched | |
| 1. | 7 Dec. 1986 | 22 Dec. 1986 | 15 |
| 2. | 9 Dec. 1986 | 23 Dec. 1986 | 14 |
| 3. | 5 Dec. 1986 | 14 Dec. 1986 | 9 |
| 4. | 27 Nov. 1986 | 11 Dec. 1986 | 14 |
| 5. | 27 Nov. 1986 | 14 Dec. 1986 | 17 |
| 6. | 5 Dec. 1986 | 20 Dec. 1986 | 15 |
| 7. | 5 Dec. 1986 | 16 Dec. 1986 | 11 |
| 8. | 5 Dec. 1986 | 20 Dec. 1986 | 15 |
| 9. | 22 Nov. 1986 | 9 Dec. 1986 | 17 |
| 10. | 22 Nov. 1986 | 16 Dec. 1986 | 24 |
| 11. | 27 Nov. 1986 | 9 Dec. 1986 | 12 |
| 12. | 27 Nov. 1986 | 4 Dec. 1986 | 7 |
| 13. | 5 Dec. 1986 | 13 Dec. 1986 | 8 |
| 14. | 5 Dec. 1986 | 16 Dec. 1986 | 11 |
| 15. | 16 Feb. 1987 | 5 Mar. 1987 | 17 |
| 16. | 16 Feb. 1987 | 6 Mar. 1987 | 18 |
| 17. | 16 Feb. 1987 | 6 Mar. 1987 | 18 |
| 18. | 9 Dec. 1986 | 23 Dec. 1986 | 14 |
| 19. | 25 Dec. 1987 | 10 Jan. 1988 | 16 |
| 20. | 31 Dec. 1987 | 12 Jan. 1988 | 12 |

Mean number of days 14.2
SD=3.98 days

TABLE 4

| Individual number | Time elapsing between hatching and 2 whorls | | Time (days) |
|-------------------|---|--------------|-------------|
| | Hatching | 2 whorls | |
| 1. | 20 June 1986 | 5 July 1986 | 15 |
| 2. | 17 Dec. 1986 | 5 Jan. 1987 | 19 |
| 3. | 20 Jan. 1986 | 17 Feb. 1987 | 28 |
| 4. | 20 Jan. 1986 | 17 Feb. 1987 | 28 |
| 5. | 16 Dec. 1986 | 23 Dec. 1986 | 7 |
| 6. | 12 Dec. 1986 | 23 Dec. 1986 | 11 |
| 7. | 15 Dec. 1986 | 23 Dec. 1986 | 8 |
| 8. | 16 Dec. 1986 | 25 Dec. 1986 | 9 |
| 9. | 15 Dec. 1986 | 22 Dec. 1986 | 7 |
| 10. | 12 Dec. 1986 | 23 Dec. 1986 | 11 |
| 11. | 9 Dec. 1986 | 23 Dec. 1986 | 14 |
| 12. | 9 Dec. 1986 | 16 Dec. 1986 | 7 |
| 13. | 16 Dec. 1986 | 23 Dec. 1986 | 7 |
| 14. | 13 Dec. 1986 | 23 Dec. 1986 | 10 |
| 15. | 11 Dec. 1986 | 16 Dec. 1986 | 5 |
| 16. | 12 Dec. 1986 | 17 Dec. 1986 | 5 |
| 17. | 6 Jan. 1987 | 14 Jan. 1987 | 8 |
| 18. | 31 Dec. 1987 | 7 Jan. 1988 | 7 |
| 19. | 28 Apr. 1986 | 2 May 1986 | 4 |
| 20. | 31 May 1986 | 9 June 1986 | 9 |
| 21. | 4 May 1986 | 10 May 1986 | 6 |
| 22. | 16 Apr. 1986 | 21 Apr. 1986 | 5 |
| 23. | 21 Apr. 1986 | 20 May 1986 | 29 |
| 24. | 21 Apr. 1986 | 20 May 1986 | 29 |
| 25. | 13 Dec. 1986 | 23 Dec. 1986 | 10 |

Mean number of days 11.92
SD=8.12

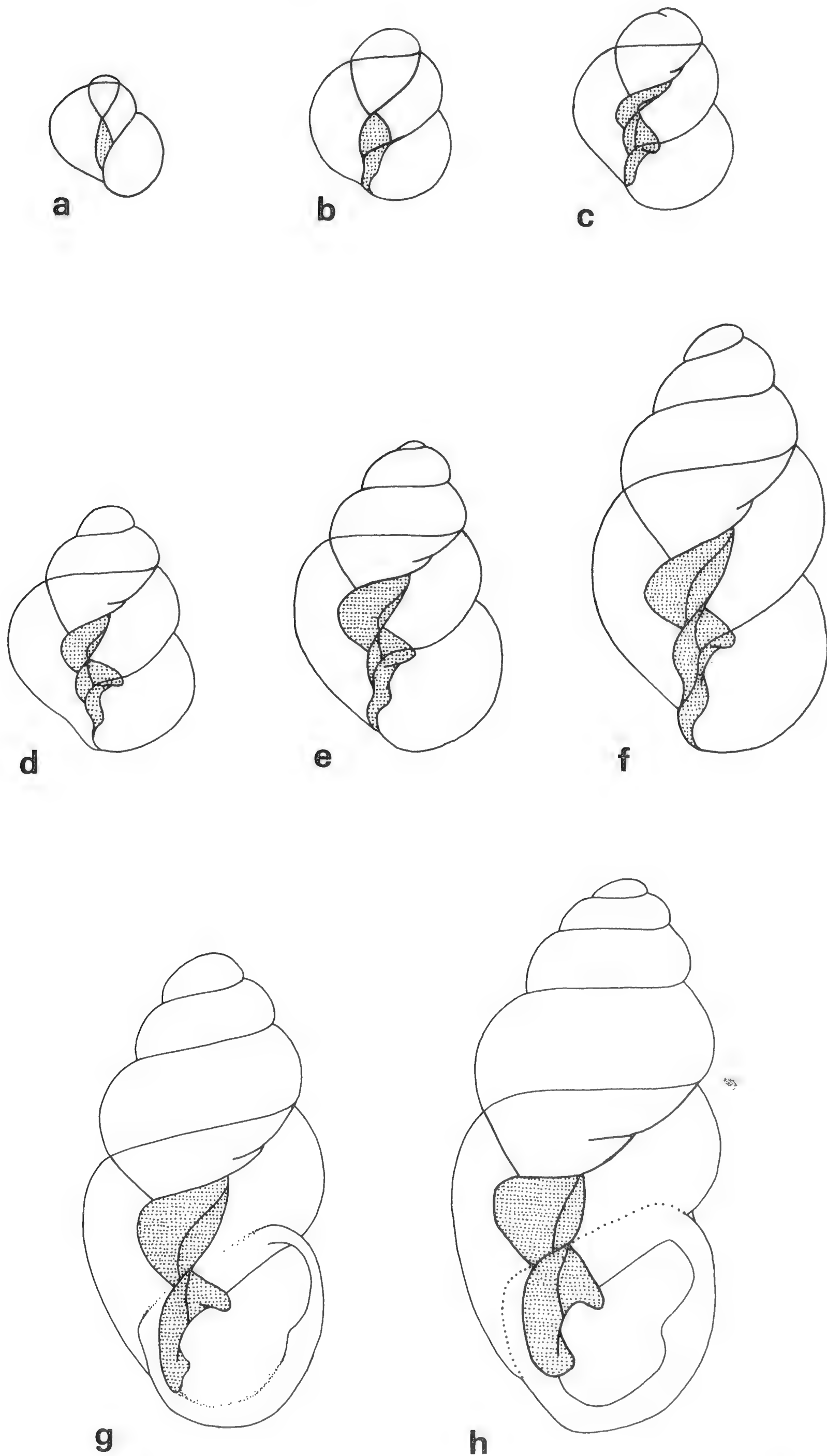


Fig. 3. *Carychium tridentatum*; growth of shell and apertural barriers. Apertural barriers dotted. Diagrammatic. For further explanations see text.

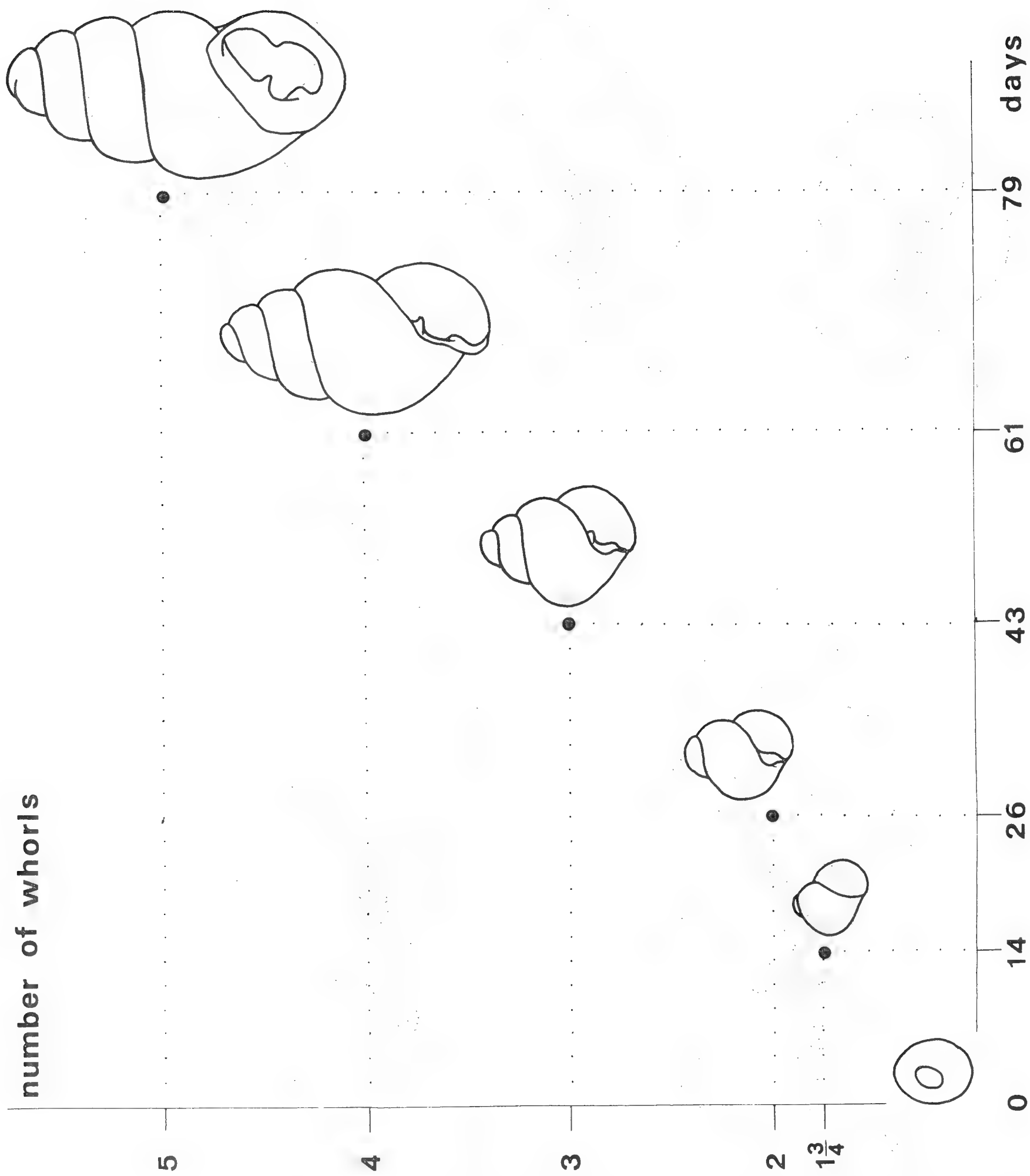


Fig. 4. Mean time required to form consecutive shell whorls.

(Tables 4–8). Fig. 4 represents the time necessary for building consecutive whorls. The shortest time from hatching to shell completion amounted to 37 days, the longest to 129 days.

The time which elapsed between 4 whorls and shell completion (Table 7) is not correlated with the ultimate number of whorls in adults.

Life span

The life span ranges from slightly less than 4 to nearly 19 months (Table 9), the mean value being 9 months and 28 days.

TABLE 5

| Time elapsing between 2 whorls and 3 whorls | | |
|---|--------------|--------------|
| Individual number | 2 whorls | 3 whorls |
| 1. | 5 Jan. 1987 | 20 Jan. 1987 |
| 2. | 23 Dec. 1986 | 5 Jan. 1987 |
| 3. | 23 Dec. 1986 | 5 Jan. 1987 |
| 4. | 25 Dec. 1986 | 5 Jan. 1987 |
| 5. | 23 Dec. 1986 | 5 Jan. 1987 |
| 6. | 23 Dec. 1986 | 26 Jan. 1987 |
| 7. | 14 Jan. 1987 | 25 Jan. 1987 |
| 8. | 18 Oct. 1987 | 28 Oct. 1987 |
| 9. | 20 May 1986 | 7 June 1986 |
| 10. | 2 May 1986 | 19 May 1986 |
| 11. | 10 May 1986 | 25 May 1986 |
| 12. | 21 Apr. 1986 | 13 May 1986 |
| 13. | 20 May 1986 | 7 June 1986 |
| 14. | 10 Dec. 1986 | 5 Jan. 1987 |
| 15. | 2 Mar. 1986 | 3 Apr. 1986 |
| 16. | 12 Mar. 1987 | 27 Mar. 1987 |
| 17. | 1 Jan. 1987 | 14 Jan. 1987 |
| 18. | 26 Dec. 1986 | 5 Jan. 1987 |
| 19. | 12 Oct. 1986 | 27 Oct. 1986 |
| 20. | 2 Jan. 1987 | 21 Jan. 1987 |

Mean number of days 17.05
SD=6.74 days

DISCUSSION

According to Morton (1955b) the morphology of the reproductive system of *C. tridentatum* undergoes seasonal changes consisting of disappearance of the penis and vas deferens. In his opinion the animal is protandrous, and only individuals collected in summer (end of July and August) have male copulatory organs i.e. are euphallic, while during the remaining part of the year they are aphaallic. Doll (1982) observed copulation in snails collected in winter (January–February) and then kept in the laboratory at 18°C, with abundant food. His hypothesis is that the snails must have become euphallic earlier than usual, as a result of altered food and temperature conditions. It is worth mentioning that a protandrous animal, i.e. an animal functioning first as a male, would have a penis and then possibly reduce it, rather than the opposite, as suggested by Doll (1982). The fact that I have observed no

TABLE 6

Time elapsing between 3 whorls and 4 whorls

| Individual number | 3 whorls | 4 whorls | Time (days) |
|---------------------------|---------------|--------------|-------------|
| 1. | 1 May 1986 | 7 June 1986 | 37 |
| 2. | 3 Apr. 1986 | 14 Apr. 1986 | 11 |
| 3. | 29 Apr. 1986 | 10 May 1986 | 11 |
| 4. | 20 Jan. 1987 | 10 Feb. 1987 | 21 |
| 5. | 14 Jan. 1987 | 26 Jan. 1987 | 12 |
| 6. | 5 Jan. 1987 | 14 Jan. 1987 | 9 |
| 7. | 5 Jan. 1987 | 14 Jan. 1987 | 9 |
| 8. | 14 Jan. 1987 | 25 Jan. 1987 | 11 |
| 9. | 5 Jan. 1987 | 20 Jan. 1987 | 15 |
| 10. | 14 Jan. 1987 | 2 Feb. 1987 | 19 |
| 11. | 26 Jan. 1987 | 10 Feb. 1987 | 15 |
| 12. | 28 Oct. 1987 | 13 Nov. 1987 | 16 |
| 13. | 30 Mar. 1986 | 14 Apr. 1986 | 15 |
| 14. | 19 May 1986 | 14 June 1986 | 26 |
| 15. | 7 June 1986 | 3 July 1986 | 26 |
| 16. | 7 Jan. 1987 | 21 Jan. 1987 | 14 |
| 17. | 27 Sept. 1986 | 27 Oct. 1986 | 30 |
| 18. | 5 Jan. 1987 | 26 Jan. 1987 | 21 |
| 19. | 28 Oct. 1987 | 26 Nov. 1987 | 29 |
| 20. | 5 Jan. 1987 | 19 Jan. 1987 | 14 |
| Mean number of days 18.05 | | | |
| SD=7.88 | | | |

TABLE 7

Time elapsing between 4 whorls and shell completion

| Individual number | 4 whorls | Shell completion | Time (days) | Whorl number in adult individual |
|--------------------------|---------------|------------------|-------------|----------------------------------|
| 1. | 7 June 1986 | 14 June 1986 | 7 | 4.5 |
| 2. | 14 Apr. 1986 | 1 May 1986 | 17 | 5.0 |
| 3. | 10 May 1986 | 27 May 1986 | 17 | 4.7 |
| 4. | 11 Sept. 1986 | 2 Oct. 1986 | 21 | 5.0 |
| 5. | 19 Sept. 1986 | 27 Oct. 1986 | 38 | 5.0 |
| 6. | 10 Feb. 1987 | 23 Feb. 1987 | 13 | 4.5 |
| 7. | 26 Jan. 1987 | 10 Feb. 1987 | 15 | 4.5 |
| 8. | 26 Jan. 1987 | 10 Feb. 1987 | 15 | 4.7 |
| 9. | 14 Jan. 1987 | 26 Jan. 1987 | 12 | 4.7 |
| 10. | 14 Jan. 1987 | 26 Jan. 1987 | 12 | 4.7 |
| 11. | 25 Feb. 1987 | 2 Apr. 1987 | 36 | 4.5 |
| 12. | 15 Oct. 1986 | 22 Nov. 1986 | 38 | 4.5 |
| 13. | 20 Jan. 1987 | 2 Feb. 1987 | 13 | 4.7 |
| 14. | 2 Feb. 1987 | 10 Feb. 1987 | 8 | 4.5 |
| 15. | 21 Jan. 1987 | 10 Feb. 1987 | 20 | 4.7 |
| 16. | 20 Jan. 1987 | 2 Feb. 1987 | 13 | 4.7 |
| 17. | 13 Nov. 1987 | 26 Nov. 1987 | 13 | 4.8 |
| 18. | 20 Dec. 1987 | 7 Jan. 1988 | 18 | 4.7 |
| 19. | 14 Apr. 1986 | 28 Apr. 1986 | 14 | 4.5 |
| 20. | 14 June 1986 | 2 July 1986 | 18 | 4.5 |
| Mean number of days 17.9 | | | | |
| SD=9.08 days | | | | |

BULMAN: LIFE HISTORY OF *CARYCHIUM*

TABLE 8

| Individual number | Growth | | | |
|----------------------|---------------|---------------------|----------------|-----------------|
| | Hatching | Shell completion | Time (days) | Whorl number |
| 1. | 24 Feb. 1986 | 27 May 1986 | 92 | 4.7 |
| 2. | 20 June 1986 | 27 Oct. 1986 | 129 | 5.0 |
| 3. | 30 June 1986 | 27 Oct. 1986 | 119 | 5.0 |
| 4. | 17 Dec. 1986 | 23 Feb. 1987 | 68 | 4.2 |
| 5. | 21 Apr. 1986 | 10 July 1986 | 80 | 4.5 |
| 6. | 17 Dec. 1986 | 2 Feb. 1987 | 47 | 4.7 |
| 7. | 19 Dec. 1986 | 26 Jan. 1987 | 38 | 4.7 |
| 8. | 6 Mar. 1987 | 18 May 1987 | 73 | 4.5 |
| 9. | 15 Dec. 1986 | 10 Feb. 1987 | 57 | 4.5 |
| 10. | 17 Dec. 1986 | 10 Feb. 1987 | 55 | 4.7 |
| 11. | 16 Dec. 1986 | 26 Jan. 1987 | 41 | 4.7 |
| 12. | 12 Dec. 1986 | 26 Jan. 1987 | 45 | 4.7 |
| 13. | 15 Dec. 1986 | 26 Jan. 1987 | 42 | 4.7 |
| 14. | 18 Dec. 1986 | 10 Feb. 1987 | 54 | 4.7 |
| 15. | 16 Dec. 1986 | 2 Feb. 1987 | 48 | 4.7 |
| 16. | 17 Dec. 1986 | 2 Apr. 1987 | 108 | 4.2 |
| 17. | 15 Dec. 1986 | 2 Feb. 1987 | 49 | 4.7 |
| 18. | 19 Sept. 1986 | 27 Oct. 1986 | 38 | 5.0 |
| 19. | 16 Dec. 1986 | 2 Feb. 1987 | 48 | 5.0 |
| 20. | 15 Dec. 1986 | 21 Jan. 1987 | 37 | 5.0 |
| 21. | 13 Dec. 1986 | 2 Feb. 1987 | 51 | 4.7 |
| 22. | 12 Dec. 1986 | 2 Feb. 1987 | 52 | 4.7 |
| 23. | 21 Dec. 1986 | 10 Feb. 1987 | 51 | 4.5 |
| 24. | 9 Dec. 1986 | 16 Feb. 1987 | 69 | 4.7 |
| 25. | 9 Dec. 1986 | 10 Feb. 1987 | 63 | 4.7 |
| 26. | 10 Apr. 1986 | 14 June 1986 | 65 | 4.5 |
| 27. | 24 Feb. 1986 | 1 May 1986 | 66 | 5.0 |
| 28. | 28 Apr. 1986 | 2 July 1986 | 65 | 4.5 |
| 29. | 24 Feb. 1986 | 27 May 1986 | 90 | 4.7 |
| 30. | 15 Oct. 1987 | 20 Dec. 1987 | 66 | 4.7 |

Mean number of days 63.5

SD=23.65

Mean number of whorls 4.7

SD=0.23

copulation in spite of numerous and frequent observations, made during four whole years, on snails kept in groups renders it doubtful that copulation took place, and suggests that laboratory conditions promote aphyllism. The capability of successful uniparental reproduction for a few generations in the laboratory, and the fact that both Morton (1955a) and Doll (1982) found eggs in samples collected in the field at any season of the year (i.e. also during periods at which the snails are supposed to be aphyllic) suggest that eggs may be produced uniparentally also in natural populations.

The mechanism of uniparental reproduction in *C. tridentatum* remains unknown. Self-fertilisation is common in the pulmonates, and species in which it is found include many Basommatophora (Purchon 1977). On the other hand, ameiotic parthenogenesis, recently described in the slug *Deroceras laeve* in which the aphyllism is also regulated by external conditions (Nicklas & Hoffmann 1981) cannot be excluded.

The egg size in my studies (mean 0.35 mm × 0.42 mm) is in agreement with the data given by Doll (1982): 0.32 mm × 0.41 mm. The covering of eggs with parental faeces was not reported by Doll (1982) or Morton (1955a). The faeces may play a variety of possible

TABLE 9

Life span

| Individual number | Sex | Hatching | Death | Life span (months and days) |
|-------------------|-----|---------------|---------------|-----------------------------|
| 1. | ♂ | 24 Feb. 1986 | 17 Oct. 1986 | 7 and 21 |
| 2. | ♀ | 24 Feb. 1986 | 11 Sept. 1986 | 6 and 15 |
| 3. | ♂ | 20 June 1986 | 30 May 1987 | 11 and 10 |
| 4. | ♂ | 30 June 1986 | 26 Oct. 1987 | 15 and 26 |
| 5. | ♀ | 17 Oct. 1986 | 26 Sept. 1987 | 11 and 9 |
| 6. | ♀ | 20 Dec. 1986 | 27 Sept. 1987 | 9 and 7 |
| 7. | ♀ | 20 Dec. 1986 | 20 June 1988 | 18 |
| 8. | ♀ | 6 Mar. 1987 | 27 Sept. 1987 | 6 and 21 |
| 9. | ♀ | 10 Apr. 1986 | 23 June 1987 | 14 and 13 |
| 10. | ♀ | 10 Oct. 1986 | 2 Feb. 1987 | 3 and 23 |
| 11. | ♀ | 10 Oct. 1986 | 26 Sept. 1987 | 11 and 6 |
| 12. | ♀ | 10 Oct. 1986 | 27 Sept. 1987 | 11 and 7 |
| 13. | ♀ | 6 Jan. 1987 | 30 May 1987 | 5 and 24 |
| 14. | ♀ | 6 Jan. 1987 | 6 May 1987 | 5 |
| 15. | ♀ | 15 Oct. 1987 | 11 Feb. 1988 | 3 and 27 |
| 16. | ♀ | 27 Oct. 1987 | 30 May 1988 | 7 and 3 |
| 17. | ♀ | 15 Oct. 1987 | 11 Feb. 1988 | 3 and 27 |
| 18. | ♀ | 14 Oct. 1986 | 27 Sept. 1987 | 11 and 13 |
| 19. | ♂ | 19 Sept. 1986 | 17 Feb. 1987 | 4 and 28 |
| 20. | ♂ | 16 Dec. 1986 | 6 Dec. 1987 | 11 and 22 |
| 21. | ♂ | 15 Dec. 1986 | 13 Feb. 1988 | 13 and 29 |
| 22. | ♀ | 12 Dec. 1986 | 6 Nov. 1987 | 10 and 25 |
| 23. | ♀ | 21 Dec. 1986 | 12 July 1988 | 18 and 22 |
| 24. | ♀ | 9 Dec. 1986 | 13 Feb. 1988 | 14 and 4 |
| 25. | ♀ | 9 Dec. 1986 | 9 Nov. 1987 | 11 |
| 26. | ♀ | 9 Dec. 1986 | 30 May 1987 | 5 and 11 |
| 27. | ♀ | 23 Dec. 1986 | 20 Dec. 1987 | 11 and 28 |
| 28. | ♂ | 16 Dec. 1986 | 29 Sept. 1987 | 9 and 13 |
| 29. | ♀ | 13 Dec. 1986 | 27 Sept. 1987 | 9 and 14 |
| 30. | ♀ | 16 Dec. 1986 | 30 May 1987 | 5 and 14 |

Mean life span 9 months and 28 days
SD=4 months and 1 day

roles. They may provide calcium necessary for the developing embryo, as suggested by Tompa (1980), who described a similar case in *Veronicella ameghini*, a species laying eggs, like *Carychium*, without calcified shells, though with a few scattered calcium carbonate crystals. His results, however, do not indicate unequivocally that it is the provision of calcium that is the main role of faeces. Another role may be to provide the young snails with symbiotic microorganisms; providing eggs with element(s) other than calcium, or finally a simple protection against dessication. The fact that eggs from which the faeces were removed failed to develop suggests that: 1. the faeces are necessary and 2. that their role is not simply protection from drying out since the humidity in the dishes was high and constant. It seems rather unlikely that the mere process of removing faeces (washing them off) alters the egg structure, as the eggs splashed with water but with faeces remaining developed normally.

The number of eggs laid by an individual in a clutch (i.e. immediately following each other) does not agree with the results of Morton (1955b). He suggested that an individual might lay 5–6 eggs per clutch. However, his prediction of the numbers of eggs in a clutch was based on histological studies on the gonad and gonoduct contents. Actually, eggs are laid singly, even if at short time intervals. In addition, no two eggs at the same development stage have been found beside each other.

According to Morton (1955a) the maximum period of egg-laying falls in June; in Doll's

(1982) opinion that period is July–August. Both those authors based their statements on field results, the former in England, the latter in the vicinity of Freiburg, FRG. The discrepancy between the results of these authors on the one hand, and mine on the other may result from 1. differences between the studied populations coming from areas of different climate and/or 2. reproductive differences between laboratory culture and field populations.

Morton (1955a) reported on small juveniles (newly hatched) which grew during summer to November to 1.2–1.5 mm. It follows from Doll's (1982) studies that such juveniles increase their size by 0.9 mm during a similar period. Both values given were deduced from field results. Comparison with my results (average time elapsing from hatching to shell completion i.e. to *c.* 1.6–1.8 mm size being *c.* 2 months) shows that growth in the laboratory is much quicker. This could be expected, considering the constant availability of food and high humidity of laboratory culture. The pattern of growth of apertural barriers found in *C. tridentatum* conforms to the general pattern found in the ellobioids.

It follows from the above considerations that many aspects of life history of the species in question require further studies. These include: the problem of seasonal aphallism and its dependence on external factors; the mechanism of uniparental reproduction; the role of egg-covering faeces. The characteristics of life cycle found in laboratory: rapid growth, short life span and distant reproductive periods, need to be verified basing on regularly taken quantitative samples from a field population.

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SOME UNUSUAL SPECIMENS OF *ACANTHOCHITONA* FROM OFF THE ISLE OF WIGHT, WEYMOUTH AND ANGLESEY

JOHN M. BAXTER¹ AND JANICE M. LIGHT²

(Accepted for publication, 24th March, 1990)

Abstract: Eight unusual specimens belonging to the genus *Acanthochitona* are described. The taxonomic status of these specimens within the currently accepted nomenclature is discussed.

INTRODUCTION

The history and the taxonomy of the British representatives of the genus *Acanthochitona* constitute a long and complicated story which is summarised by Kaas (1985). Kaas supports the historical position; that is that there are three species of *Acanthochitona* in the British fauna. *Acanthochitona fascicularis* is quite distinctive, but with the other two species: *Acanthochitona crinitus* and *Acanthochitona discrepans*, there is considerable overlap in characteristics. *Acanthochitona crinitus*, in particular, is a highly variable species (Kaas 1985, Baxter pers obs.). This paper describes eight unusual specimens of *Acanthochitona* from three different locations; two off the south coast of England and one off Anglesey, North Wales, and discusses the problems of ascribing them to the existing taxa.

DESCRIPTIONS

Isle of Wight: The three specimens described were collected in grab samples from spoil grounds off Nab Tower from depths of between 30 and 40 metres. The animals were preserved in alcohol, and as a result they were slightly to moderately curled, thus making accurate measurements of length and width difficult.

Specimen 1. Grab sample at 50°35.03'N, 0°59.86'W. Depth: 30–40 metres.

Moderate sized animal, estimated to measure 16.5 mm in length and 9.5 mm in width, giving a length:width ratio of 1.75:1. Valve 4 measured 2.6 mm in length and 4.3 mm in width, with a very rounded anterior edge and a pronounced beak. The jugal region of the intermediate valves is well defined, narrow with nearly parallel sides and has the typical longitudinal, furrow-like sculpturing. The head and tail valves and the lateral regions of the intermediate valves are covered by drop-shaped, widely spaced, regularly distributed dorsal papillae. The valve colouration is a subtle mosaic of beige, blue or olive green.

The girdle bears 19 tufts of bristles, with the typical arrangement of 4 tufts around the

¹ Marine Biology Station, Queen's University Belfast, The Strand, Portaferry, Co. Down, Northern Ireland.

² 88 Peperharow Road, Godalming, Surrey, England, GU7 2PN.

Address reprint requests to Dr. J. M. Baxter, Nature Conservancy Council, Scotland Headquarters, 12 Hope Terrace, Edinburgh, Scotland, EH9 2AS.

head valve and one either side at each valve intersection and atypically with an extra single tuft behind the tail valve. The tufts comprise short, bluntly pointed, straight orange or colourless bristles. The girdle is covered by very densely packed, very fine, slender, slightly curved spicules. Interspersed amongst these, over the whole girdle, but concentrated towards the outer half are numerous, stout, curved, pointed spines, 250 μm in length and 50 μm in diameter. The margin of the girdle is fringed by a dense array of straight, pointed spines.

Specimen 2. Grab sample at 50°36.12'N, 0°55.05'W. Depth: 35 metres.

Moderate sized animal, estimated to measure 21.5 mm in length and 14.0 mm in width giving a length:width ratio of 1.53:1. Valve 4 measured 3.0 mm in length and 4.8 mm in width, with a rounded anterior edge and a small beak. The jugal region of the intermediate valves is well defined, relatively narrow and with postero-anterior diverging sides and typical sculpturing. The head and tail valves and the lateral regions of the intermediate valves are covered by drop-shaped to elongate drop-shaped, widely spaced, regularly distributed dorsal papillae. The valve colouration is a mottling of yellow, brown, blue and pink.

The girdle bears 19 tufts of bristles arranged in a similar manner to specimen 1. The tufts comprise long, very slightly curved, pointed colourless bristles. The girdle is covered by moderately densely packed, minutely fine, very slender, slightly curved spicules. Interspersed amongst these, over the whole girdle, and even into the intersections between the valves are numerous, stout, curved, pointed spines. The margin of the girdle is fringed by a dense array of straight, pointed spines.

Specimen 3. Grab sample at 50°36.12'N, 0°55.05'W. Depth: 35 metres.

Small sized animal, measuring 12.1 mm in length and 7.7 mm in width giving a length:width ratio of 1.57:1. Valve 4 measured 1.7 mm in length and 3.5 mm in width, with an angular anterior edge and a gradual beak. The jugal region of the intermediate valves is well defined, narrow and with postero-anterior diverging sides and typical longitudinal, furrow-like sculpturing. The head and tail valves and the lateral regions of the intermediate valves are covered by round to drop-shaped, widely spaced, regularly distributed dorsal papillae which appear to be increasing in size towards the anterior margin of the valves. The valve colouration is a yellowish-beige with some blue-green mottling.

The girdle bears 19 tufts of bristles arranged in a similar manner to specimen 1. The tufts comprise long, straight or very slightly curved, pointed colourless bristles. The girdle is covered by moderately densely packed, minutely fine, very slender, slightly curved spicules. Interspersed amongst these, over the whole girdle, and even into the intersections between the valves are numerous, stout, curved, pointed spines. The margin of the girdle is fringed by a dense array of straight, pointed spines.

Weymouth: The three animals were collected in grab samples from a depth of 25 metres. The animals were preserved in alcohol, and as a result they were slightly curled making accurate measurements difficult.

Specimen 4. Grab sample at 50°36.09'N, 02°17.07'W. Depth: 25 metres.

Moderate sized animal (Pl. 32), estimated to measure 13.5 mm in length and 9.0 mm in width, giving a length:width ratio of 1.50:1. Valve 4 measured 1.8 mm in length and 3.8 mm in width, with a very rounded anterior edge and a pronounced beak. The jugal region of the intermediate valves is well defined, of moderate width with nearly parallel sides and typical sculpturing. The head and tail valves and the lateral regions of the intermediate valves are covered by drop-shaped, widely spaced, regularly distributed dorsal papillae. The valve



PLATE 32

Specimen No. 4 from off Weymouth showing the two extra tufts of bristles situated behind the tail valve.

colouration is a subtle mosaic of beige, blue and olive green.

The girdle bears 20 tufts of bristles, with 4 tufts around the head valve and one either side at each valve intersection and two tufts behind the tail valve. The tufts comprise long, sharply pointed, straight or slightly curved orange or colourless bristles. The girdle is covered by very densely packed, very fine, slender, slightly curved spicules. Interspersed amongst these over the whole girdle are numerous, stout, curved, pointed spines. The margin of the girdle is fringed by a dense array of straight, pointed spines.

Specimen 5. Grab sample at 50°36.09'N, 02°14.08'W. Depth: 25 metres.

Moderate sized animal, estimated to measure 18.0 mm in length and 9.5 mm in width, giving a length:width ratio of 1.89:1. Valve 4 measured 2.6 mm in length and 4.8 mm in width, with an angular anterior edge and a pronounced beak. The jugal region of the intermediate valves is well defined, of moderate width with diverging sides and typical sculpturing. The head and tail valves and the lateral regions of the intermediate valves are covered by round to oval-shaped, regularly distributed dorsal papillae. The valve colouration is a mottling of beige, blue and olive green.

The girdle bears 19 tufts of bristles, arranged in a similar manner to specimen 1. The tufts comprise long, bluntly pointed, straight or slightly curved colourless bristles. The girdle is covered by densely packed, very fine, slender, slightly curved spicules. Interspersed amongst these in great numbers over the whole girdle are stout, curved, pointed spines. The margin of the girdle is fringed by a dense array of straight, pointed spines.

Specimen 6. Grab sample at 50°36.09'N, 02°14.08'W. Depth: 25 metres.

Small sized animal, estimated to measure 10.0 mm in length and 5.5 mm in width, giving a length:width ratio of 1.81:1. Valve 4 measured 1.4 mm in length and 3.0 mm in width, with a rounded edge and a pronounced beak. The jugal region of the intermediate valves is well defined, of moderate width with almost parallel sides and with typical longitudinal, furrow-like sculpturing. The head and tail valves and the lateral regions of the intermediate valves are covered by drop-shaped, widely distributed dorsal papillae. The valve colouration is a subtle mosaic of beige, blue and olive green.

The girdle bears 19 tufts of bristles arranged in a similar manner to specimen 1. The tufts comprise long, bluntly pointed, straight or slightly curved colourless bristles. The girdle is covered by densely packed, very fine, slender, slightly curved spicules. Interspersed amongst these but concentrated in the outer region of the girdle are numerous, stout, curved, pointed spines. The margin of the girdle is fringed by a dense array of straight, pointed spines.

Anglesey: The two specimens were collected in dredge samples taken from the North of Anglesey at a depth of 50 metres. The animals were preserved in alcohol/glycerine and were moderately curled, thus making accurate length and width measurements difficult.

Specimen 7. Dredge sample at 53°32'N, 04°31'W. Depth: 50 metres.

Moderate sized animal, estimated to measure 25.5 mm in length and 14.0 mm in width giving a length:width ratio of 1.82:1. Valve 4 measured 4.0 mm in length and 7.1 mm in width, with a smoothly rounded anterior edge and an almost straight posterior edge with no beak. The jugal region of the intermediate valves is very well defined, markedly elevated, narrow and with slightly postero-anterior diverging sides and has distinctive longitudinal furrow-like sculpturing and noticeable transverse growth interruption lines. The head and tail valves and the lateral regions of the intermediate valves are covered by round to slightly oval, closely spaced, evenly distributed dorsal papillae of a uniform size. The valve colouration is a mosaic of beige, yellow, olive green and blue mottling.

The girdle bears 19 tufts of bristles arranged in a similar manner to specimen 1. The tufts appear insignificant and comprise very short, densely packed bristles. The girdle overall has a 'bald' or leathery appearance. It is covered by very widely distributed, minute spicules with larger, curved spines of 120 μm to 250 μm length very sparsely interspersed amongst these. The margin of the girdle is fringed by very short, bluntly pointed spines which are quite insignificant.

Specimen 8. Dredge sample at 53°32'N, 04°31'W. Depth: 50 metres.

Large sized animal, estimated to measure 33.0 mm in length and 18.0 mm in width giving a length:width ratio of 1.83:1. Valve 4 measured 4.5 mm in length and 7.0 mm in width, with a smoothly rounded anterior edge and an almost straight posterior edge with no beak. This specimen is very similar to specimen 7 in all details, except that the girdle has 20 tufts of bristles, arranged as in specimen 4.

DISCUSSION

The diagnoses of all eight specimens are summarised in Table 1, but they do have a number of points in common:

- a). All eight specimens have either 1 or 2 extra tufts of bristles in comparison with the typical number of 18.
- b). The samples were collected from relatively deep water, >25 metres.
- c). None of the specimens can be readily classified as belonging to any of the three currently recognised British species from the descriptions given by Kaas (1985):

Acanthochitona fascicularis: Up to 45 mm long; end valves and latero-pleural areas of intermediate valves covered with small, much crowded, round, flat-topped or slightly concave granules; jugal area somewhat raised, sharply separated from the latero-pleural area.

Acanthochitona crinitus: Up to 25 mm long, length less than two times the width, papillae on end valves and latero-pleural regions larger, wider apart, oval to drop-shaped; jugal area hardly raised, not sharply separated, back not carinated, side slopes rounded. Girdle covered with small spicules (<50 μm), with long ones dispersed through-out (<320 μm), marginal fringe of spines.

Acanthochitona discrepans: Up to 30 mm long, length at least two times the width (ie. long and narrow), papillae on end valves and latero-pleural regions larger, wider apart, oval to drop-shaped; jugal area hardly raised, not sharply separated, back carinated, side slopes almost straight. Girdle velvety, covered with densely packed, small, straight, sharply pointed spicules (<40 μm). Bristles short, occasionally one or two extra tufts behind the tail valve. Marginal spicules short.

It is not the purpose of this paper to enter into a detailed discussion on the taxonomy of the *Acanthochitona*. Kaas (1985) presents an excellent resume of the history of the nomenclature, but unfortunately leaves the validity of certain of the taxonomic criteria unresolved. The specimens described here cannot be confidently placed within any of the existing British taxa working within the restrictions imposed by the above descriptions. There is a high degree of intraspecific variation in the *Acanthochitona*; in particular *A. crinitus* (Kaas 1985), and the actual range of such variation has not been fully described although studies on Irish

populations would seem to indicate that it is very wide (Baxter and Jones, in preparation).

It is remarkable that all specimens found in these samples have one or two extra tufts of bristles. This character is only mentioned in the diagnosis of *A. discrepans* by Kaas (1985) and was indeed an important character in the initial establishment of that species. Kaas (1985) however also states that he has a specimen, '(K4935)', located to Pointe de Barfleur in Normandy, with an extra tuft, but which in all other respects it is a 'normal' *crinitus*. He does not, however, commit himself to an identification of the specimen.

All the specimens have a length:width ratio of <2 , this is a '*crinitus*' character rather than a '*discrepans*' character. The dorsal papillae of the specimens from the Isle of Wight and Weymouth are more-or-less drop-shaped and widely spaced, consistent with both *A. crinitus* and *A. discrepans*. The specimens from Anglesey have round, densely packed dorsal papillae, the jugal area is raised and the valves are angular in outline, all characteristics more closely similar to those described for *A. fascicularis*.

The girdle spiculation of the specimens from the two Channel localities is also quite different from that of the Anglesey specimens. Those from the Isle of Wight and Weymouth have a girdle which is densely or moderately-densely covered with fine spicules and interspersed with larger spines ('*crinitus/fascicularis*' type), generally pronounced tufts of bristles and a dense marginal fringe. The specimens from Anglesey are very different. The almost 'bald' (velvety) appearance is a feature of *A. discrepans* but the occurrence of interspersed larger spines is not. The insignificant tufts of bristles and marginal fringe are '*discrepans/fascicularis*'-like.

CONCLUSION

Clearly, with the existing definite descriptions of British *Acanthochitona* species, these specimens cannot be located satisfactorily within the existing taxa. Equally it would be unwise to describe two new species on the basis of these few specimens; especially before the full range of intraspecific variation in the existing species has been determined. It is, however, clear that the occurrence of extra tufts of bristles is not diagnostic of *A. discrepans* as it is defined at the present. It is only with the study of specimens from as wide a range of geographic localities as possible that the true intraspecific ranges can be determined. Further specimens (also from relatively deep water) from the west coast of Ireland (J.B. pers. comm.) have also been found to consistently have extra tufts of bristles.

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TABLE 1
Table summarising the morphological characteristics of the eight specimens described

| Morphological feature | Specimen 1 | Specimen 2 | Specimen 3 | Specimen 4 | Specimen 5 | Specimen 6 | Specimen 7 | Specimen 8 |
|-------------------------|--|---|---|---|--|--|--|--|
| <i>Valves:</i> | | | | | | | | |
| Anterior edge | rounded | rounded | angular | rounded | angular | rounded | rounded | rounded |
| Beak | pronounced | small | gradual | pronounced | pronounced | pronounced | absent | absent |
| <i>Dorsal papillae:</i> | | | | | | | | |
| Shape | drop | drop | round-drop | drop | round-oval | drop | round-slightly oval | round-slightly oval |
| Spacing | wide | wide | wide | wide | wide | wide | close | close |
| Distribution | regular | regular | regular | regular | regular | regular | regular | regular |
| <i>Girdle:</i> | | | | | | | | |
| Number of tufts | 19 | 19 | 19 | 20 | 19 | 19 | 19 | 20 |
| Tuft bristles | short, bluntly pointed, straight | long, pointed, slightly curved | long, pointed, straight | long, pointed, straight or slightly curved | long, bluntly pointed, straight or slightly curved | long, pointed, straight or slightly curved | very short, densely packed | very short, densely packed |
| <i>Spicules</i> | | | | | | | | |
| | fine, slender, slightly curved, densely packed | minutely fine, very slender, slightly curved, moderately densely packed | minutely fine, very slender, slightly curved, moderately densely packed | fine, slender, slightly curved, moderately densely packed | fine, slender, slightly curved, densely packed | fine, slender, slightly curved, densely packed | minute, very widely distributed | minute, very widely distributed |
| <i>Spines</i> | | | | | | | | |
| | numerous, stout, curved, pointed | numerous, stout, curved, pointed | numerous, stout, curved, pointed | very numerous, stout, curved, pointed | very numerous, stout, curved, pointed | very numerous, stout, curved, pointed | occasional, curved, pointed | occasional, curved, pointed |
| Fringe spines | dense, straight, pointed | dense, straight, pointed | dense, straight, pointed | very dense, long, straight, pointed | very dense, long, straight, pointed | very dense, long, straight, pointed | insignificant, very short, bluntly pointed | insignificant, very short, bluntly pointed |

THE MOLLUSCAN FAUNAS FROM TWO EARLY POST-GLACIAL TUFA DEPOSITS IN SUFFOLK

R. C. PREECE¹

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Abstract: Non-marine Mollusca have been analysed from samples of two tufa deposits in Suffolk. The first was collected in the 1930s from a site near Tuddenham in the Finn Valley and the second was obtained in 1980 from a temporary section at Chantry near Ipswich. Comparisons with more complete radiocarbon-dated sequences from south-east England indicate that the former accumulated sometime between ~9500–8500 BP and the latter between ~8500–8000 BP. Both faunas comprise communities which cannot be matched at any site in Britain today. The occurrence of *Discus ruderatus* and *Nesovitrea petronella*, two taxa now extinct in Britain, is of particular interest.

The purpose of this brief paper is to put on record the molluscan faunas of two early Post-glacial tufas in Suffolk, the only such deposits known from this county.

1. Finn Valley (TM 194476).

The occurrence of a fossiliferous deposit in the 'Finn Valley' has been known for over fifty years. Kennard, for example, repeatedly referred to this locality in various papers but hitherto no description of either the site or its fauna has ever been published. Details of the site, given here, are based on unpublished maps and reports by the late H. E. P. Spencer housed in Ipswich Museum together with additional details gleaned from A. S. Kennard's notebooks now in the Department of Palaeontology, British Museum (Natural History).

The site lies on the west bank of the River Finn (Fynn on some maps), 1 km south of Tuddenham, N.E. of Ipswich. It was discovered in 1938 as the result of trenches excavated in connection with a pumping station installed by Deben Rural District Council. The notes and maps indicate that further trial pits were excavated in the field immediately north of the pumping station (TM 194476). The general stratigraphy is recorded as:

Soil, with small pieces of chalk and shells of swamp Mollusca

Peat with marly streaks, shells, including oysters and mussels, mediaeval pottery and much white quartz

Shelly marl

Stony, light-coloured sand passing into

Greyish sandy plastic clay

Comminuted Red Crag with base of large stones and pieces of ironstone

London Clay (not seen *in situ*)

Sediment thicknesses are not given for this generalised sequence but they are quoted for nine other trial pits (Spencer, ms). The sediments appear to be quite variable and the full sequence is not present everywhere. The deposits never exceed 2 m in total thickness. Attempts to relocate the deposit by augering in 1981 proved unsuccessful.

A small subsample (100 g) from a lump of 'shelly marl' (actually a calcareous tufa), collected by Spencer and lodged in Ipswich Museum, has been analysed quantitatively (Table 1). The fauna is identical to that listed by A. S. Kennard in his notebooks and included in his collection in the BM(NH).

¹Department of Zoology, Downing Street, Cambridge CB2 3EJ.

TABLE 1

Mollusca (>0.5 mm) from tufa deposits at Tuddenham (Finn Valley) and Chantry

| | <i>Finn Valley</i> | <i>Chantry</i> |
|--|--------------------|----------------|
| sample weight (g) | 100 | 1000 |
| <i>Lymnaea truncatula</i> (Müller) | 6 | 10 |
| <i>Carychium minimum</i> Müller | 52 | 97 |
| <i>Carychium tridentatum</i> (Risso) | 246 | 250 |
| <i>Cochlicopa lubrica</i> (Müller) | 85 | 21 |
| <i>Columella edentula</i> (Draparnaud) | 64 | 11 |
| <i>Vertigo pusilla</i> Müller | 27 | 19 |
| <i>Vertigo substriata</i> (Jeffreys) | 113 | 22 |
| <i>Vertigo moulinsiana</i> (Dupuy) | 2 | — |
| <i>Vertigo angustior</i> Jeffreys | 35 | 66 |
| <i>Vallonia costata</i> (Müller) | 24 | 102 |
| <i>Vallonia pulchella</i> (Müller) | — | 25 |
| <i>Vallonia pulchella/excentrica</i> | 2 | 10 |
| <i>Acanthinula aculeata</i> (Müller) | 5 | 9 |
| <i>Punctum pygmaeum</i> (Draparnaud) | 44 | 22 |
| <i>Discus ruderatus</i> (Férussac) | 8 | 3 |
| <i>Discus rotundatus</i> (Müller) | — | 17 |
| <i>Vitrina pellucida</i> (Müller) | 1 | — |
| <i>Vitrea contracta</i> (Westerlund) | 85 | 23 |
| <i>Nesovitrea cf petronella</i> (Pfeiffer) | 1 | 3 |
| <i>Nesovitrea hammonis</i> (Ström) | 63 | 14 |
| <i>Aegopinella pura</i> (Alder) | — | 4 |
| <i>Aegopinella nitidula</i> (Draparnaud) | 46 | 67 |
| <i>Zonitoides nitidus</i> (Müller) | 33 | 16 |
| <i>Deroceras/Limax</i> | 11 | 2 |
| <i>Euconulus fulvus</i> (Müller) | 80 | 6 |
| <i>Clausilia bidentata</i> (Ström) | 4 | 5 |
| <i>Trichia hispida</i> (Linné) | 1 | 5 |
| <i>Cepaea/Arianta</i> | 6 | 2 |
| <i>Cepaea</i> spp | — | + |
| <i>Arianta arbustorum</i> (Linné) | + | — |
| <i>Pisidium casertanum</i> (Poli) | 136 ¹ | — |
| <i>Pisidium personatum</i> Malm | 32 ¹ | 1 |

¹ valves

2. Chantry (TM 135421)

This site was discovered in 1980 by Mr R. A. D. Markham (Ipswich Museum) at the southern end of the Chantry Estate, S. W. Ipswich. Lumps of tufa were sampled from spoil from a manhole drain in a new housing development in the south of Belmont Road. The precise stratigraphy is unknown. A small block of soft tufa was carefully trimmed down to 1 kg and also analysed (Table 1).

The faunas from the two sites are remarkably similar. Both faunas contain species that are now scarce in East Anglia (e.g. *Vertigo pusilla*, *V. substriata*, *V. angustior*) and comprise an assemblage that cannot be found at any single site in Britain today. The frequency of shells was much greater in the Finn Valley assemblage and it contained a higher proportion of aquatic and marsh taxa reflecting a wetter depositional environment. The occurrence of *Discus ruderatus* and *Nesovitrea petronella*, both now extinct in Britain, is particularly noteworthy.

Discus ruderatus was present in Britain for only a relatively short period in the early Post-glacial between ~9,500–8,500 BP (Kerney, Preece & Turner 1980) and the Finn Valley sample would therefore appear to date from this time. At Chantry, *D. ruderatus* is present in

low numbers together with *D. rotundatus* also at low frequency ($\sim 2\%$). The latter species appeared in Kent at $\sim 8,500$ BP (Kerney *et al.* 1980, R. C. Preece unpublished) and their coexistence in these proportions suggests an age between 8,000–8,500 BP. In other words, the Chantry sample not only represents a drier facies but it also accumulated at a slightly later date.

Nesovitrea petronella was first recognised as a British fossil from Post-glacial tufa deposits in Lincolnshire (Kennard & Musham 1937). Kennard (ms) also lists it from Rykofs pit, Broxbourne and Nazeing (Allison, Godwin & Warren 1952). At all these sites, like the two in Suffolk, it was associated with *D. ruderatus* (Preece & Robinson 1984), as it was in an Ipswichian (last) interglacial deposit in Lincolnshire (Holyoak & Preece 1985).

There has been much debate as to whether *N. petronella* is specifically distinct from *N. hammonis*. Waldén (1966) upholds their separation on the basis of colour (*hammonis* is usually brown, *petronella* colourless or pale greenish) and consistent biometric differences. The height of the spire is taller in *petronella* and the width of the last whorl relatively narrower. Although consistent, these differences are quite subtle and it is impossible to reliably separate young individuals with a diameter of less than 3 mm. The numbers of *petronella* listed from the two Suffolk sites should therefore be regarded as minimum totals, since most of the fossil *Nesovitrea* were smaller than this critical size. Dr H. W. Waldén has kindly examined the original series in the Kennard collection and has confirmed that both *N. hammonis* and *N. petronella* are present in the Finn valley deposit.

ACKNOWLEDGEMENTS

My thanks are due to Mr R. A. D. Markham and Mr I. J. Killeen for providing me with samples from these two deposits and associated notes about them. Mr J. Cooper (BMNH) also provide information from the Kennard notebooks and Dr. H. W. Waldén (Göteborg) kindly checked the identifications of the *Nesovitrea*.

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TWO ETHIOPIAN STREPTAXIDS (GASTROPODA: PULMONATA: STREPTAXIDAE)

B. VERDCOURT¹

(Accepted for publication, 24th March, 1990)

Abstract: Notes are given on the anatomy of *Ptychotrema denticulatum* (Morelet) and *Gulella zemenensis* is described as new. Despite the availability of a certain amount of comparative anatomical evidence the shell is still the only certain way of distinguishing the two genera.

Reading of my attempt to name an Ethiopian helicid collected by himself (Verdcourt 1987, p. 420) Dr. D. S. Brown pointed out that he had a considerable general collection of Ethiopian snails made in 1965. The naming of these would be attended by all the well nigh insuperable difficulties I enumerated in that note, but I offered to examine any Streptaxidae. Only three lots of this family had been collected representing two species, one fairly well known at least from its shell, the other undescribed; since both had been collected in spirit some new information was elicited. The importance of collecting all possible information for as many species as possible has already been explained in a previous note (Verdcourt 1987, p. 48).

Ptychotrema denticulatum (Morelet)

1872 *Ennea denticulata* Morelet, p. 202, Pl. 9, fig. 10

1874 *Ennea denticulata*; Jickeli, p. 29

1883 *Ennea denticulata*; Bourguignat, pp. 76, 118

1885 *Ennea denticulata*; Tryon, p. 94, Pl. 27, figs. 12, 13

1888 *Ennea denticulata*; Pollonera, p. 53

1928 *Ptychotrema denticulatum*; Connolly, p. 164.

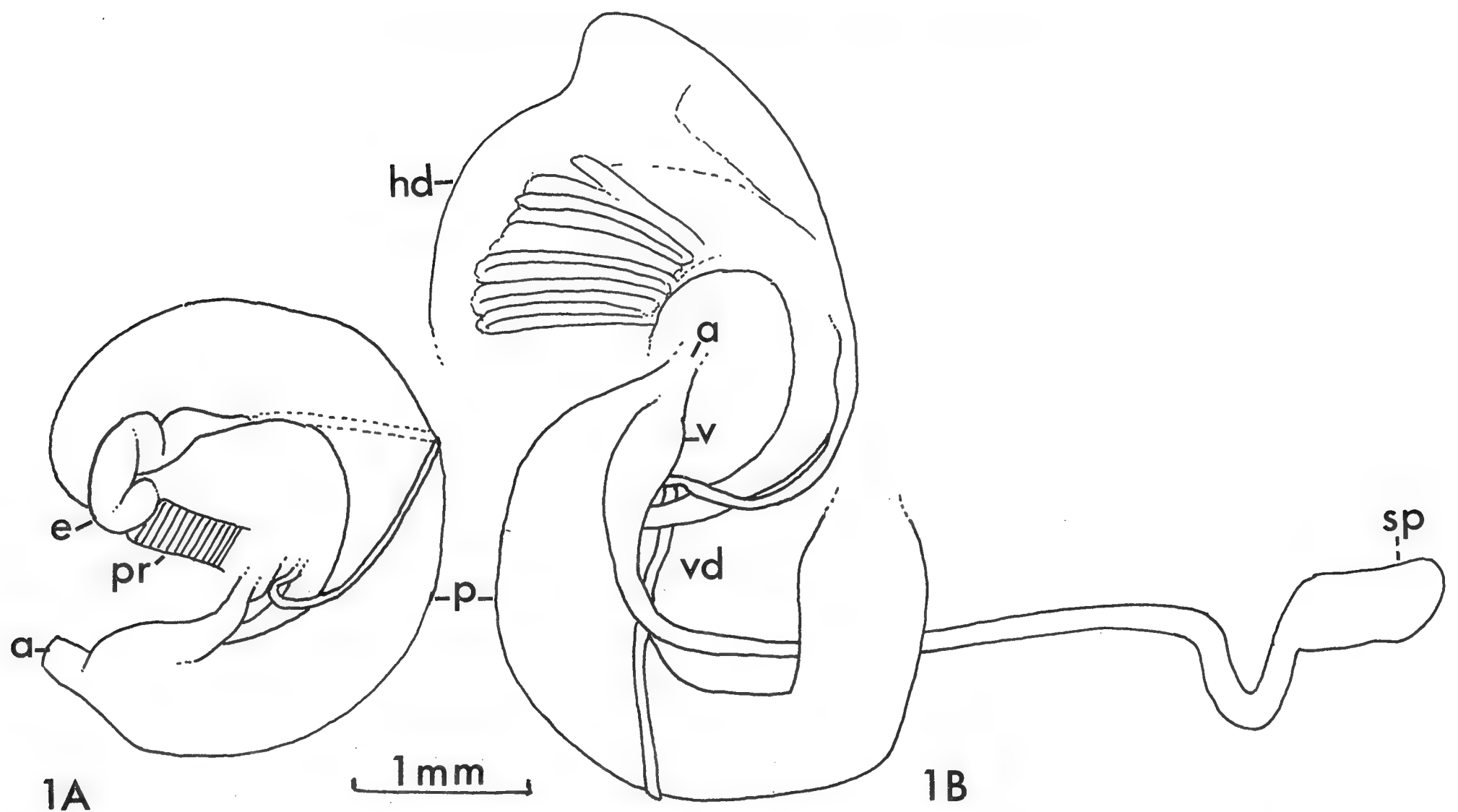
1940 *Ptychotrema* (*Ennea*) *denticulatum*; Bacci, p. 450.

1951 *Ptychotrema* (*Ennea*) *denticulatum*; Bacci, p. 100 (as '*denticulata*')

ETHIOPIA. NE. shore of Lake Awasa, forest, 7 Aug. 1965, leg. D. S. Brown (Brit. Mus. (Nat. Hist.)) and a further lot from the same place on same date, leg. D. S. Brown & M. V. Prosser (Brit. Mus. (Nat. Hist.)). The gross genital anatomy is of the simple unspecialized type which occurs in many genera of the Streptaxidae, lacking penial appendages and with a long narrow spermathecal duct (Figs. 1a,b). Internally the penial pilasters are extremely densely aculeolate with nearly 400 spinules (Fig. 2) of very varying sizes; more in fact than I have seen in any other streptaxid. Three of the largest spinules nearest to the atrium are bifid or trifid. The salivary gland as in all other members of the Ptychotrematinae which I have examined is relatively extremely large comparable with the penis and radula sac. The radula measures 2.2×0.35 mm. with 73 rows of teeth, the formula being 16:C:16. The first six lateral teeth from the centre outwards are more or less equal, the subsequent ten reducing gradually, only the final six being noticeably small. The central tooth is well marked and aculeate (Pl. 33).

The third lot of material comprised several specimens of a *Gulella* closely allied to but coming from an area to the north of *G. shoaensis* Verdcourt (1985, p. 120); although similar in shape and particularly the dentition of the outer lip, the sinuses to the left and right of the

¹ Spring Cottage, Kimbers Lane, Maidenhead, Berks.



Figs. 1a,b. *Ptychotrema denticulatum* (Morelet). Two views of part of lower genital ducts. a=atrium; e=epiphallus; hd=hermaphrodite duct; p=penis; pr=penial retractor muscle; sp=spermatheca; v=vagina; vd=vas deferens.

basal lamella are very different and the columella lobe has a terminal nodule rather than a thickened margin.

***Gulella zemenensis* sp. nov.** Figs. 3, 4.

Description: Shell oblong-cylindrical, imperforate but with a deep umbilical impression, glossy creamy white but presumably transparent in life; spire elongate, the sides slightly convex, the apex broadly conical. Whorls 7, increasing \pm regularly, the body whorl occupying about half the shell, slightly convex; apical two whorls essentially smooth and glossy save for some very fine spiral and radial scratches at high magnification; rest covered with strong close ribs which become obscure on the body whorl beneath the suture and above the aperture; about 40 are visible from above on both of the next two whorls; traces of a spiral element occur between and to the right of the ribs; suture moderately impressed and serrated by the ribs. Aperture rounded-quadrate with a strong angular lamella which cuts off a sinus with the upwardly inclined uppermost outer lip lamella; the lower lip lamella is larger and \pm horizontal, the two together corresponding with a deep outer pit; a strong mid-basal tooth corresponding with a small outer pit; a strong mid-columella lamella and above this the columella lobe is nodulated at the apex. Peristome thick and reflected.

Dimensions: Height 5.51–5.74* mm, breadth 2.61*–2.71 mm, height of aperture 1.64–1.83*, breadth 1.40–1.83* (asterisk indicates holotype measurements).

Distribution: Ethiopia, Begemder, E. of Lake Tana, 6 km NW. of Addis Zemen (formerly Ifaq), 23 Aug. 1965, D. S. Brown & M. V. Prosser (holotype and paratypes in British Museum (Nat. Hist.) 1989001 and 1989002).

Unfortunately the genitalia of the two specimens examined both proved vestigial and it was not advisable to sacrifice further paratypes. The radula is rather characteristic in that the central tooth is square with a very narrow cusp. The formula is 8.C.8.

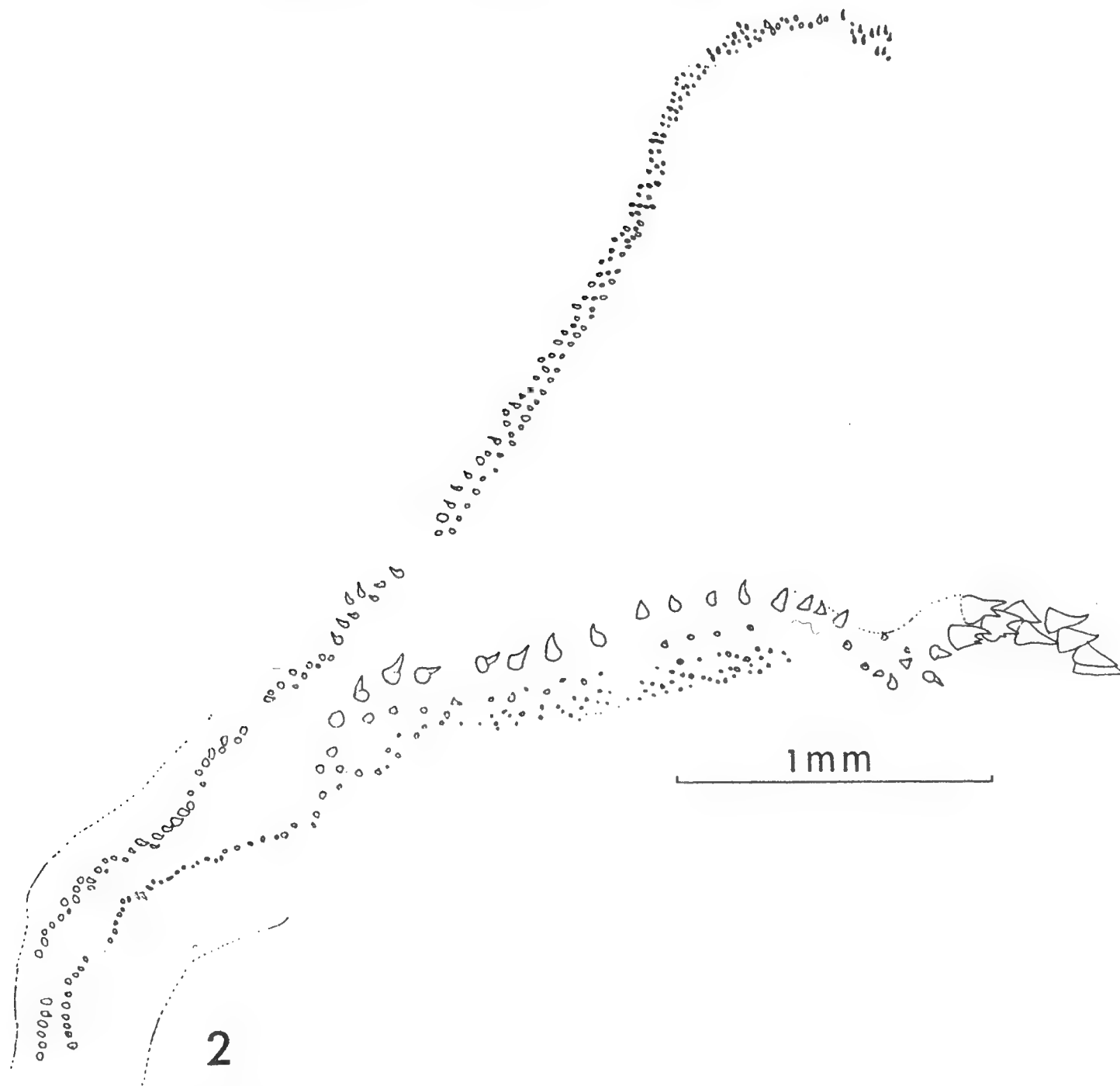


Fig. 2. *Ptychotrema denticulatum* (Morelet). Penis opened out to show internal armature.

DISCUSSION

If one uses shell characters alone it is possible to make a tidy enough classification for practical use – *Ptychotrema* and *Gulella* being usually readily identified by apertural dentition characters. In fact a fairly complicated infrastructure of subgenera and sections has been built up and some of these have the appearance of being natural; a few I am certain are monophyletic (e.g. *Parennea* and *Primigulella*). Needless to say there are several peripheral mostly monospecific taxa tacked on. A certain amount of anatomical information is now available although curiously Pilsbry (1919) gives none whatever for any species of either *Gulella* or *Ptychotrema* although I find it difficult to believe there was no spirit material in the large collection at his disposal. I (Verdcourt 1987) have already mentioned sources of anatomical information and the fact that Degner (1934) has already commented on the lack of correlation between shell characters and anatomy in the two genera mentioned which is rather unexpected. Within *Gulella* itself a number of species with only one or few apertural teeth and very similar shells have vastly different penial armaments. The basic pattern of the genital anatomy is remarkably constant throughout the family but penial appendages occur in a number of species some of which are certainly only distantly related. Some account of this has been given (Verdcourt 1961) although at the time I most unfortunately did not record information on penial ornamentation. The penial ornamentation displays great diversity and I suspect will ultimately prove to be the most valuable character although at present far too few species have been examined. It is not even known how constant it is in one species but I doubt it varies much.

Some 100 species have had radulae examined but no obvious correlations are apparent.

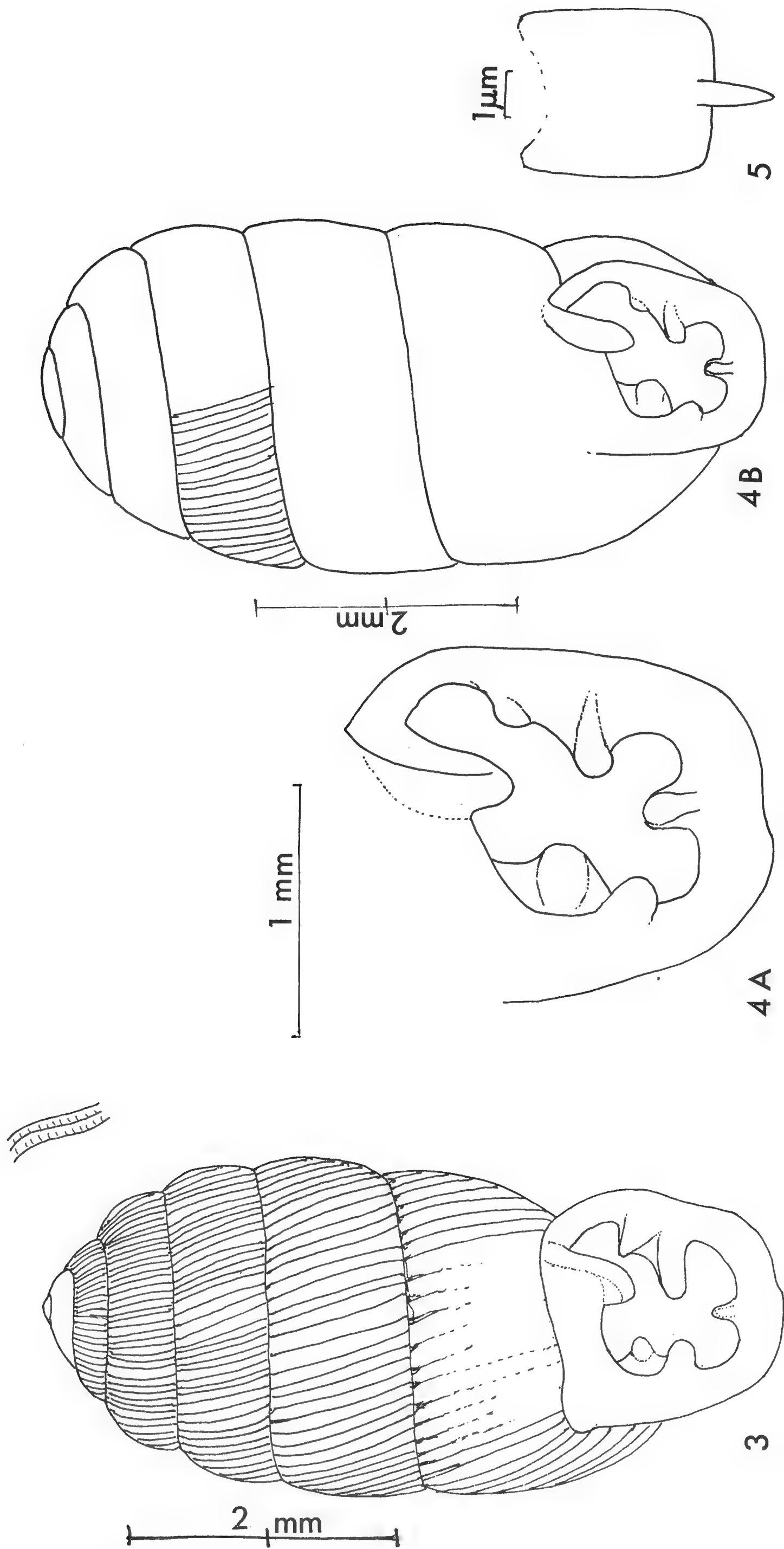


Fig. 3. *Gulella zemenensis* sp. nov. Ethiopia. Holotype. Figs. 4a, b. *Gulella zemenensis* sp. nov. Ethiopia. Paratype. Fig. 5. *Gulella zemenensis* sp. nov. Ethiopia. Central tooth of radula.

Aiken (1981) made a valuable survey of 48 species of *Gulella* in South Africa (*Ptychotrema* does not occur there) which he divided into four groups; a large group of 42 species with unicuspid teeth having a long area of basal attachment and a short cutting cusp; a group of four species with a short attachment and longer cusps; one species with the teeth not long and aculeate but the length of the attachment exceeding the length of the cusp; and finally a single species *G. browni* Van Bruggen has flexible teeth and the laterals tricuspid. Multicuspid teeth are rare in *Gulella* but were reported by Connolly (1930) over half a century ago and by Verdcourt (1953). This condition has arisen separately on three occasions since the species involved, *G. browni*, *G. conospira polynematica* (Pilsbry) and *G. usambarica* (Craven) are clearly totally unrelated. Connolly actually proposed that Pilsbry's section *Conogulella* should be raised to generic rank purely on account of the bicuspid teeth but I agree with Ortiz de Zarate Lopez and Ortiz de Zarate Rocandio (1955, p. 127) that this is an inadequate reason, particularly as the genital anatomy is shared by other species. Hugh Watson frequently mentioned to me that he considered care should be given to the use of uncorrelated radula characters since quite marked changes could occur as a result of adaptation to different diets. Virtually nothing is known about the feeding habits of the Streptaxidae. I noted only the bigger species fed on larger faster prey which is only to be expected but it is possible that some may have given up tackling live prey and scavenge. It is clear the three species with 2–3-cuspid teeth have different dietary habits compared with the vast majority with narrow aculeate teeth. It is pointless to speculate without observations; even more so to guess if the condition is derived. In *G. usambarensis* with its large central tooth it might be primitive. Of the 48 species examined by Aiken only three, all in the large group, lacked central teeth which may be genuinely rare in southern Africa.

I have considered it worthwhile to summarize in tabular form the available information and since it is so fragmentary the species are listed in alphabetical order.

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TABLE 1

| Name | Radula formula | Special radular characters | Penial appendage | Penial armature | Source |
|--|-------------------|---|------------------|--|--|
| GULELLA Pfr. | | | | | |
| <i>bicolor</i> (Hutton) | 9.C.9 | | none | 50 spinules, huge one at anterior end and few small in lines anteriorly | Annandale & Prasad (1920) |
| <i>buchholzi</i> (von Martens) | | | | | Stoliczka (1871) |
| <i>cavidens</i> (von Martens) | 21.0.21 | first 9 laterals large, rest small | none | many small spinules the 6 largest at posterior end | Degner (1934) |
| <i>columella</i> (E.A.Smith) | 10.0.10 | | none | | unpublished data, Kenya, Muguga, leg. B. Verdcourt |
| <i>conica</i> (von Martens) | 30.0.30 | | none | many small spinules and one huge posterior one | Degner (1934) |
| <i>conospira conospira</i> (von Martens) | 38.0.38 | laterals bicuspid | none | scattered lines of various sizes; 7 median medium-sized and 1 huge one at posterior end | Lopez & Rocandio (1955) |
| <i>conospira polynemetica</i> Pilsbry | 27(–45).C.27(–45) | laterals bicuspid, 28 onwards rudimentary | present | restricted to appendage, 1 huge one at end of duct and 15–20 medium ones beneath; duct continues above large spinule as gland-filled organ rather few spinules in upper half and 1 large posterior one much bigger than the rest | Peile in Connolly (1930) |
| <i>dautzenbergi</i> Connolly | | | | | Degner (1934) |
| <i>dohrni</i> (E.A.Smith) | 59.0.59 | first 2 quite small, 8–14 largest | none | rather few spinules in upper half and 1 large posterior one much bigger than the rest | Lopez & Rocandio (1955) |
| <i>excuciata</i> Connolly | 19.0.19 | increase to 7, 8, & 9 then decrease | none | pilasters densely covered with small spinules throughout length | Verdcourt (1987) |
| <i>exogonia</i> (von Martens) | 19–21.0.19–21 | | none | lower $\frac{3}{4}$ of lumen covered by a tessellation of long and short prismatic tubercles, the longer ones in the | unpublished data, Uganda, Ruwenzori, leg. Å. Holm 61 |

| Name | Radula formula | Special radular characters | Penial appendage | Penial armature | Source |
|----------------------------------|--------------------------|--------------------------------------|---|---|---|
| <i>grossa</i> (von Martens) | 36.C.36 | | apical | central portion; all bear minute apical straight spinules but those on the longer tubercles are larger and slightly darker; near the apex the lumen has folds of much more closely placed elongate tubercles so that the spinules are approximate (in all there are several hundred spinules) | Thiele (1911) Verdcourt (1953) |
| <i>hedwigae</i> Degner | 22.0.22 | | none | about 25 small spinules in lines and 2 much larger at posterior end | Degner (1934) |
| <i>incisa</i> Degner | 15.0.15 | | present but internal and not visible from outside | many small in the narrow appendage; 2 big ones in middle of penial lumen | Degner (1934) |
| <i>ingloria</i> (Preston) | | | none | numerous rather large spinules all over | Verdcourt (1985) |
| <i>io</i> Verdcourt | 7.C.7(–13) | vestige of central, 8–13 rudimentary | none | only 3 small spinules in characteristic position | Verdcourt (1979) |
| <i>kemblei</i> Connolly | 12–13.0.12–13 13.0.13 | trace of side cusps | none | ditto | Degner (1934) |
| <i>ngorongoroensis</i> Verdcourt | 8.C.8 | outer 3 much smaller than inner | none | numerous very small, 20 small and 2 big towards posterior end | Degner (1934) |
| <i>oloitae</i> Lopez & Rocandio | 30.?.30 | | none | numerous spinules of assorted sizes | Verdcourt (1985) |
| <i>pilula</i> (Preston) | 29.C.29 | 4 extra vestigial | | characteristic, 2 medium and 1 large at posterior end | Lopez & Rocandio (1955) |
| <i>porcina</i> Connolly | 46.0.46 | Aiken B group | basal | and 1 large at posterior end followed by 12 medium to rather larger in a line then 25 small | Peile in Connolly (1930) |
| <i>prodigiosa</i> (Thiele) | 11.C.11 | teeth uniform | | probably as in <i>usagarica</i> | Thiele (1933) |
| <i>sexdentata</i> (von Martens) | 19.0.19 | | | | unpublished data |
| | | | | | Tanzania, Uluguru Mts., Bunduki, leg. J. Bond |

| Name | Radula formula | Special radular characters | Penial appendage | Penial armature | Source |
|---|--------------------|--|------------------|--|---|
| <i>stylodon</i> (von Martens) | | | none | characteristics, huge one at posterior end with smaller ones beneath then 8 medium then 7 large then 10 small; Lopez & Rocandio indicate 1 large with medium ones below then a dense cluster of small ones | Degner (1934) Lopez & Rocandio (1955) |
| <i>taitensis</i> Verdcourt <i>ugandensis cheranganiensis</i> Verdcourt | 42.0.42 20.0.20 | Aiken B group | none | posterior part of penial lumen very densely covered with several 100 small spinules an area of basal ones less dense towards the anterior end and enlarged considerably but still quite small; the anterior part of lumen appears to be free of spinules | Verdcourt (1963) unpublished data, Uganda, Mt. Elgon, East side, 2970 m. leg. Holm 16 |
| <i>usagarica</i> (Crosse) | 32.C.32 | | basal | numerous small spinules in penis and appendage including its narrow apical part; spinules have serrate tips | Verdcourt & Venmans (1956) |
| <i>usambarensis</i> (Craven) | 26.C.26 | very robust central tooth; all save central and first lateral have serrated inner margin to cusp squarish central with narrow cusp | | | Verdcourt (1953) |
| <i>zemenensis</i> Verdcourt | 9.C.9 | | none | | present study |
| PTYCHOTREMA Pfr. | | | | | |
| <i>anceyi</i> (Neville) | 26.C.26 | 4 first laterals largest | none | numerous (250) very small spinules throughout | Lopez & Rocandio (1955) |
| <i>boangolense</i> (D'Ailly) | 24.C.24 | | none | numerous small spinules in line throughout length of lumen and separate line of 20 larger ones | Lopez & Rocandio (1955) |
| <i>denticulatum</i> (Morelet) | 16.C.16 | | none | | |

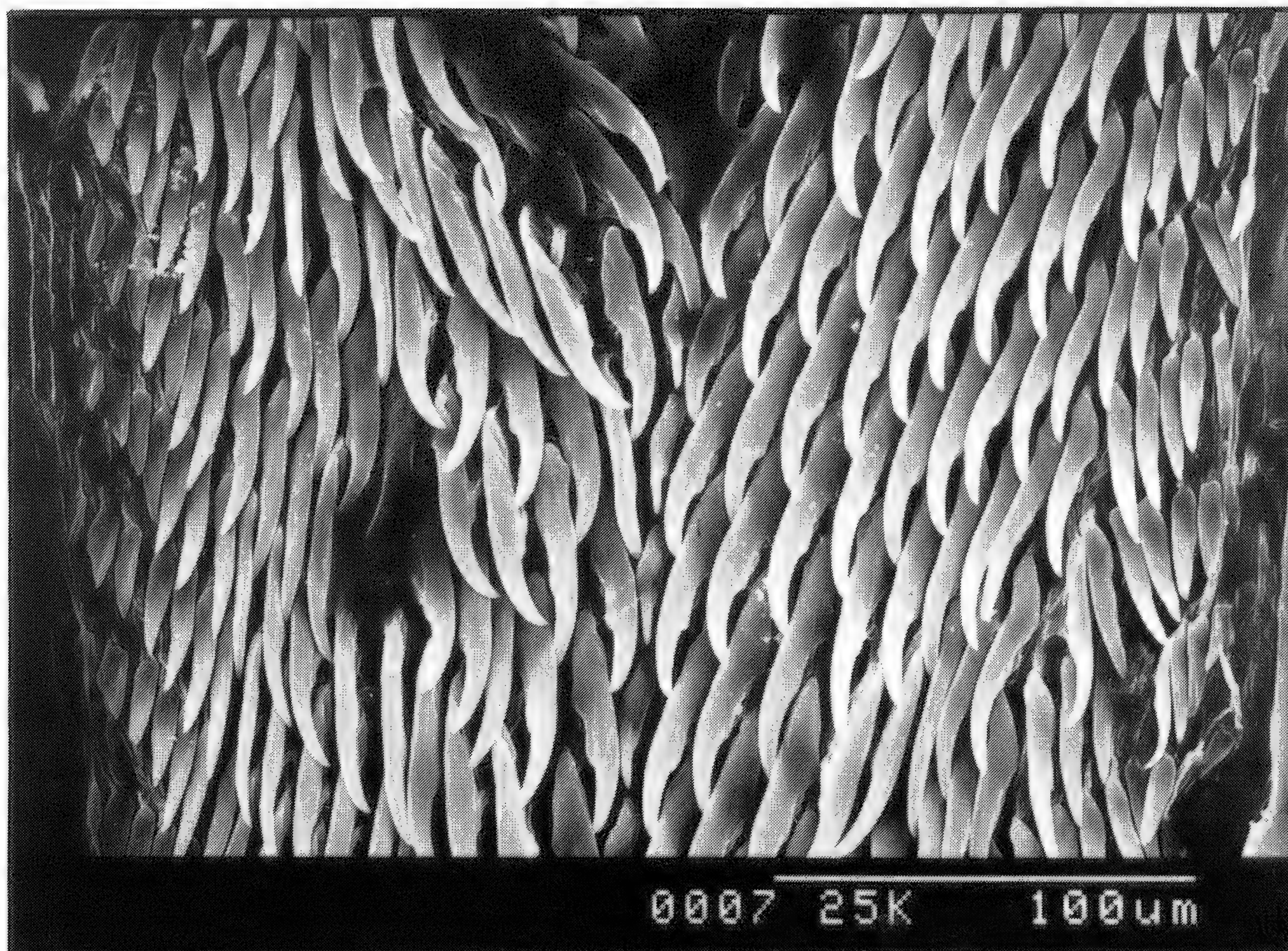


PLATE 33
Ptychotrema denticulatum (Morelet). S.E.M. of part of radula.

| Name | Radula formula | Special radular characters | Penial appendage | Penial armature | Source |
|---------------------------------|----------------|--|------------------|---|-------------------------|
| <i>deruptum</i> Degner | 20.C.20 | first 3 bigger, the second largest, 19 & 20 very small | none | about 50 or so; 10 fairly large on one side, 20 minute followed by 6 small and 7 larger which are 4-cusped, finally 11 small | Degner (1934) |
| <i>dohrni</i> (E.A.Smith) | 59.0.59 | | | | |
| <i>elegantulum</i> (Pfeiffer) | 25.?..25 | | none? | characteristic spinules on the pilasters | Degner (1934) |
| <i>martensi</i> (D'Ailly) | | | none | fairly numerous spinules in anterior half of penis lumen | Degner (1934) |
| <i>mucronatum</i> (von Martens) | 51.C.51 | | none | no internal armature shown in Degner's figure | Degner (1934) |
| <i>newtoni</i> (Girard) | 51.C.51 | | none | numerous small spinules in penis and appendage | Lopez & Rocandio (1955) |
| <i>subtusangulatum</i> Degner | | | present | spinules at posterior end of penis and appendage, with a very large one at end of appendage with right-angled bend and sharply acute apex | Degner (1934) |

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TERRESTRIAL MOLLUSC FAUNAS FROM SOME SOUTH PENNINE WOODLANDS

P. TATTERSFIELD¹

(Accepted for publication, 24th March, 1990)

Abstract: Terrestrial mollusc faunas are described from 38 semi-natural, deciduous woodlands in the geographically variable area of the South Pennines, England. The same number of species (44) is recorded from woodlands on limestone and from those on millstone grit-shales, but 20 and 12 species are significantly more frequent in these two geological categories respectively. Many of the limestone and gritstone/shale species can be classified as calcicoles and hygrophiles respectively. Faunas from the limestone sites are relatively homogeneous but those from millstone grit/shale woods are very variable, both within and between sites. These differences appear to be related to levels of habitat diversity and especially to the occurrence of marshy areas. Several geographical groupings are tentatively identified among the limestone sites. The affinities of the sites with similar woodlands elsewhere in the British Isles, and the conservation significance of the fauna, are discussed.

INTRODUCTION

Broad-leaved woodland is the richest habitat type for terrestrial Mollusca in temperate northern Europe and much descriptive work has been done on woodland faunas (Cameron 1973, 1978, Paul 1975, Bishop 1976, 1977, Waldén 1981, Wäreborn 1969). In the Pennines, the faunas of the Craven area around Malham have been extensively studied (Stratton 1956, Cameron & Redfern 1972, Cameron 1978) but those from the extreme southern areas, including the Peak District, have only been reported in general terms (eg. Spray 1968, Clinging 1985).

This study examines the mollusc faunas of semi-natural, broad-leaved woodlands in the south Pennines. The region is centred around the Peak District National Park and is of considerable biogeographic interest because of the occurrence of both taxa with northern and southern distributions in the British Isles. The close proximity of strikingly different geologies and the great variations in topography and elevation also provide opportunities for interesting comparisons. The faunas from the region are also compared with those from similar woodlands elsewhere.

Nomenclature for Mollusca and plants follow Kerney and Cameron (1979) and Clapham, Tutin and Warburg (1981) respectively.

THE AREA AND HABITATS STUDIED

General characteristics

Fig. 1 shows the area and woodlands sampled. The region is dominated by rocks of the Carboniferous Series. A belt of millstone grit and shales (the Dark Peak) which supports predominantly acidophilous vegetation borders a central limestone plateau, the White Peak,

¹ Bettfield Clough Cottage, Castleton Road, Chapel-en-le-Frith, Stockport, England, SK12 6PE.

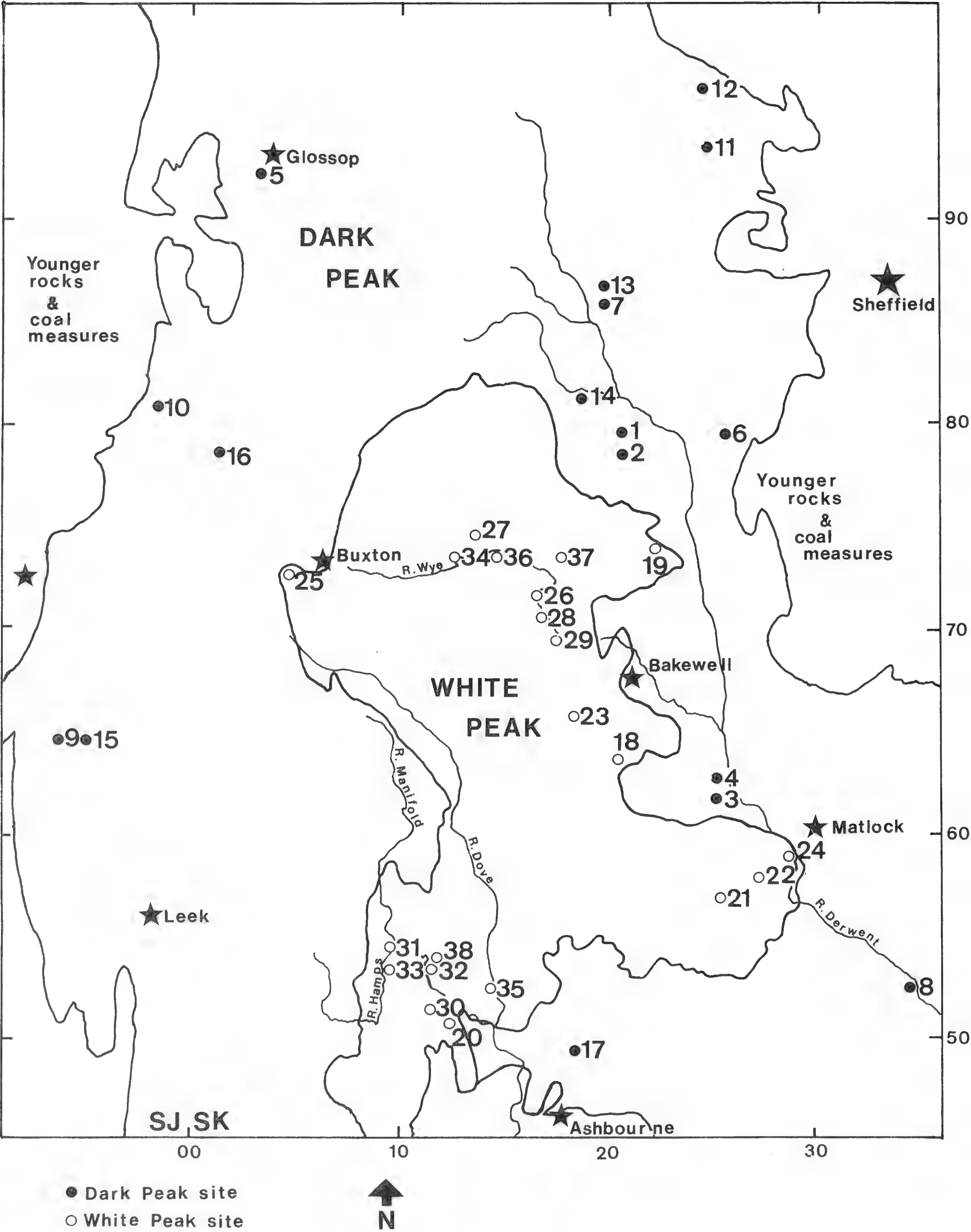


Fig. 1. The study area and locations of the woodlands sampled. Ordnance Survey National Grid lines at 10 km intervals are shown around the edges of the map.

which is incised by mostly dry, steep-sided valleys or dales. Elevation in the White Peak ranges from about 150 m above sea level (a.s.l.) in the dale bottoms to 310 m a.s.l. on the plateau. The Dark Peak rises to about 610 m a.s.l. on the Kinder-Bleaklow plateaux in the north of the region but falls considerably to both the east and south.

The great variation in relief has a strong influence on the local climate, but in general, there is a trend for the more southern and eastern sites to have lower levels of rainfall, higher temperatures and more sunshine than the more elevated north and western areas. These trends also tend to result in the more western sites having a more 'oceanic' climate. Clapham (1969) and Garland (1985) (and references therein) provide more information about the climate of the region.

Woodland cover in the area is low (only 5.4% of the land surface in the Peak District National Park (Chalmers 1974) compared with a national average of 8% (Anderson & Shimwell 1981), and of this, most semi-natural stands (i.e. those consisting predominantly of native species) are confined to the dales in the White Peak and the narrow valleys or cloughs in the Dark Peak.

The White Peak Woodlands

Aspects of the ecology and status of the limestone woodlands of Derbyshire and Staffordshire have been described by Moss (1913), Merton (1970), Anderson and Shimwell (1981), Pigott (1969) and Ratcliffe (1977). Ash *Fraxinus excelsior* dominates the canopy in most woods and they are situated, almost without exception, on the extremely well-drained, shallow soils of the dale sides. Limestone scree, and outcrops occur extensively on slopes of more than about 15°. Fragments of limestone are typically numerous throughout the soil profile of the generally shallow and base rich rendzinas. Leaching and downwash from the plateau soils locally influence base status. Surface water is limited and marshy areas are uncommon, although some dales have permanent streams or rivers and others contain ephemeral streams which only flow during the wetter seasons.

Sycamore *Acer pseudoplatanus*, wych elm *Ulmus glabra* and maple *Acer campestre* sometimes accompany ash in the canopy, and hazel *Corylus avellana* is usually the dominant understorey shrub. Tufted hair grass *Deschampsia cespitosa*, dogs mercury *Mercurialis perennis* or wood false brome *Brachypodium sylvaticum* typically dominate the soils of greatest, intermediate and least depth respectively. The ground flora is often rich in herbaceous species.

Pigott (1969) and Merton (1970) provide accounts of the likely origins of the White Peak woodlands. Many of the woodlands are thought to be secondary, having originated in the nineteenth century following the disuse of pasture or cessation of cultivation. These woodlands typically have an even age structure and consist mostly of ash and sycamore. In contrast, about 5% of the total area of woodland probably represents ancient woodland, retaining at least some of the structure and composition of the woodland which formerly occupied the dales (Pigott 1969). These areas of older woodland can, according to Pigott (1969), be identified by their uneven age structure, the occurrence of lime and oak and the presence of several vascular plant of restricted distribution such as mountain melick *Melica nutans* and lily of the valley *Convallaria majalis*. However, valley structure, as well as previous interference can also influence the occurrence of several of these ancient woodland species (Merton, 1970) and the composition of each woodland needs to be regarded as a complex interaction of these factors.

The Dark Peak Woodlands

The ecology of the gritstone and shale woodlands has been less well documented (but see Anderson & Shimwell 1981). Semi-natural stands are highly fragmented and mostly occur as small blocks in the narrow valleys (locally known as cloughs) and on the broader valley

TABLE 1
Physical and vegetation characteristics of the woodlands

| No. | Site | Soil pH | | Altitude | | Location | | Major woodland trees | Other features |
|----------------------------|---------------------|---------|---------|----------|---------|----------|----------|--|--|
| | | Mean | Maximum | Mean | Minimum | Easting | Northing | | |
| <i>Dark Peak Woodlands</i> | | | | | | | | | |
| 1 | Abney Clough | 6.42 | 7.0 | 237.5 | 205 | 20 | 79 | <i>Alnus/Betula-Quercus/Fagus</i> plantation | Species rich flushes/stream |
| 2 | Bretton Clough | 5.33 | 6.5 | 265 | 250 | 20 | 78 | <i>Quercus-Betula</i> | <i>Tilia cordata</i> present/stream |
| 3 | Clough Wood | | | 182.5 | 130 | 25 | 61 | <i>Acer pseudoplatanus-Quercus-Betula/Alnus</i> | Tall herb and sedge marsh/Stream flushes |
| 4 | Sabine Hey Wood | 5.5 | 6.0 | 180 | 150 | 25 | 62 | <i>Acer pseudoplatanus-Ulmus/Quercus-Betula</i> | Tall herb marsh/stream |
| 5 | Long Clough | | | 235 | 220 | 03 | 92 | <i>Quercus-Betula/Alnus</i> | Flushes/streams |
| 6 | Padley Woods | | | 230 | 185 | 25 | 79 | <i>Quercus-Betula</i> | Flushes/stream |
| 7 | Parkin Clough | | | 265 | 180 | 19 | 35 | <i>Quercus/Acer pseudoplatanus/Sorbus aucuparia</i> | Stream/flushes/steep slopes/adjacent to conifer plantation |
| 8 | Shining Cliff Woods | 5.3 | 6.5 | 237.5 | 200 | 33 | 52 | <i>Quercus-Betula/Alnus/Fraxinus/Ulmus</i> | <i>Tilia cordata</i> present/species-rich flushes/streams |
| 9 | Flash Wood | 6.5 | 6.5 | 191.5 | 183 | SJ 93 | 64 | <i>Quercus-Betula/Alnus/Fraxinus</i> | Stream/species rich flushes/some plantation |
| 10 | Brownside Clough | 5.5 | 6.5 | 257.5 | 240 | SJ 98 | 81 | <i>Quercus-Betula/Alnus/Fraxinus</i> | Flushes/part trampled by stock/stream |
| 11 | Agden Clough | 5.75 | 6.5 | 257 | 230 | 24 | 93 | <i>Salix cf. cinerea/Quercus-Betula</i> | Boggy areas with <i>Sphagnum</i> /stream |
| 12 | Ewden Clough | 5.5 | 6.5 | 221 | 197 | 24 | 96 | <i>Alnus/Ulmus/Fagus</i> plantation | Stream |
| 13 | Ladybower Wood | 4.25 | 4.5 | 288.5 | 242 | 19 | 86 | <i>Quercus-Betula</i> | Dry heath understorey |
| 14 | The Car | 5.5 | 5.5 | 242.5 | 222 | 18 | 81 | <i>Fraxinus-Alnus</i> | <i>Filipendula</i> marsh and flushes/stream |
| 15 | Cartlidge Wood | 6.5 | 7.5 | 199 | 183 | SJ 94 | 64 | <i>Alnus/Betula-Fraxinus/Quercus-Betula/some Acer pseudoplatanus</i> | Tall herb marsh/flushes/stream/ditches |
| 16 | Hillbridge Wood | 172.5 | | 212.5 | 195 | 01 | 78 | <i>Quercus-Betula/Alnus</i> | Stream |
| 17 | Fenny Bently | | | 172.5 | 160 | 18 | 49 | <i>Fraxinus</i> /plantation | Stream |

| No. | Site | Soil pH | | Altitude | | Location | | Major woodland trees | Other features |
|-----------------------------|----------------------|---------|---------|----------|---------|----------|----------|---|---|
| | | Mean | Maximum | Mean | Minimum | Easting | Northing | | |
| <i>White Peak Woodlands</i> | | | | | | | | | |
| 18 | Bradford Dale | | | 185 | 150 | 20 | 63 | Mostly <i>Acer pseudoplatanus</i> - <i>Fraxinus</i> , some <i>Fagus</i> -conifer plantation | |
| 19 | Coombs Dale | | | 205 | 150 | 22 | 74 | <i>Acer pseudoplatanus</i> - <i>Ulmus</i> - <i>Fraxinus</i> | Pigott (1969) |
| 20 | Hinkley Wood | | | 197.5 | 140 | 12 | 50 | Mixed. <i>Fraxinus</i> /areas of <i>Fagus</i> / <i>Tilia</i> | Contains <i>Tilia</i> ; Pigott (1969) |
| 21 | Ible Wood | 8.0 | 8.0 | 210 | 170 | 25 | 56 | <i>Fraxinus</i> , sometimes with <i>Acer pseudoplatanus</i> & <i>Ulmus</i> | Contains <i>Tilia</i> ; Pigott (1969) |
| 22 | Middleton Wood | 8.0 | 8.0 | 195 | 145 | 27 | 57 | <i>Fraxinus</i> , sometimes with <i>Acer pseudoplatanus</i> & <i>Ulmus</i> | Contains <i>Tilia</i> ; Pigott (1969) |
| 23 | Lathkill Dale woods | | | 235 | 200 | 18 | 65 | <i>Fraxinus</i> , some plantation | Pigott (1969) |
| 24 | Matlock Wood north | | | 127.5 | 80 | 29 | 58 | <i>Fraxinus</i> - <i>Tilia</i> - <i>Ulmus</i> | Contains <i>Tilia</i> ; Pigott (1969) |
| 25 | Grin Plantation | 7.0 | 7.5 | 370 | 330 | 04 | 72 | <i>Acer</i> , <i>Fraxinus</i> , <i>Fagus</i> , <i>Ulmus</i> | Heavily used as a public amenity |
| 26 | Monsal Dale | | | 215 | 159 | 16 | 71 | Mostly <i>Fraxinus</i> , much regenerating | |
| 27 | Monks Dale | 7.25 | 7.25 | 280 | 235 | 13 | 74 | <i>Fraxinus</i> | Pigott (1969); ephemeral stream |
| 28 | Taddington Wood | 7.0 | 7.0 | 240 | 170 | 16 | 70 | <i>Fraxinus</i> - <i>Acer pseudoplatanus</i> with <i>Acer campestre</i> | |
| 29 | Great Shacklow Wood | 5.75 | 6.0 | 227.5 | 165 | 17 | 69 | <i>Fraxinus</i> plus much plantation of conifers, <i>Fagus</i> , <i>Acer pseudoplatanus</i> | Actively managed for forestry |
| 30 | Musden/Rushley Woods | 7.0 | 7.0 | 230 | 180 | 11 | 51 | <i>Fraxinus</i> - <i>Acer pseudoplatanus</i> with <i>Ulmus</i> , <i>Tilia</i> and some <i>Quercus petraea</i> | Contains <i>Tilia</i> ; Pigott (1969) |
| 31 | Ladyside Wood | 7.0 | 7.0 | 227.5 | 180 | 09 | 54 | <i>Fraxinus</i> - <i>Ulmus</i> | |
| 32 | Cheshire Wood | 7.5 | 7.5 | 205 | 160 | 11 | 53 | <i>Fraxinus</i> | |
| 33 | Old Soles Wood | 7.25 | 7.0 | 240 | 180 | 09 | 53 | <i>Fraxinus</i> | |
| 34 | Meadow Wood | 7.0 | 7.0 | 262.5 | 225 | 12 | 73 | <i>Fraxinus</i> - <i>Ulmus</i> / <i>Fagus</i> plantation | |
| 35 | Dovedale Wood | 7.5 | 7.5 | 227.5 | 155 | 14 | 52 | Mostly <i>Fraxinus</i> but very heterogeneous | Contains several plant species with restricted distribution |
| 36 | Priestcliff Lees | 7.25 | 7.0 | 252.5 | 205 | 14 | 73 | <i>Fraxinus</i> | |
| 37 | Cressbrook Dale | 7.25 | 7.25 | 237.5 | 175 | 17 | 73 | <i>Fraxinus</i> but some <i>Acer pseudoplatanus</i> | Contains <i>Tilia</i> ; Pigott (1969); see Merton (1970) |
| 38 | Bincliff Wood | 7.0 | 7.0 | 232.5 | 165 | 11 | 53 | <i>Fraxinus</i> | Contains <i>Tilia</i> ; Pigott (1969) |

Pigott (1969) – woodlands which contain at least some of the characteristics of ancient woodland according to Pigott (1969).

slopes. The soils and vegetation are very variable. Oak (*Quercus petraea*, *Q. robur*, hybrids or both) and birch *Betula* spp. tend to dominate the canopy on the acidic, podsolised organic or mineral soils. The stands are more mixed with ash, alder *Alnus glutinosa*, willows *Salix* spp. and wych elm in the damper drainage channels and valley bottoms where the brown earth and alluvial soils have a mull humus. Streams, flushes and small marshy areas are frequent in most woods. The understorey is often sparse as a result of uncontrolled and excessive grazing but hazel, bird cherry *Prunus padus* and willow scrub sometimes occur, especially on the damper soils.

The field layer is often locally variable, with species-poor communities of wavy-hair grass *Deschampsia flexuosa*, heath bedstraw *Galium saxatile* and other calcifuge species on the drier slopes. Richer floras occur on areas with mull humus, in the wet areas and on the valley bottoms. Opposite-leaved golden saxifrage *Chrysosplenium oppositifolium*, soft rush *Juncus effusus*, greater woodrush *Luzula sylvatica* and other damp-demanding species occur in and around the wet areas. The effects of grazing, which tends to impoverish the ground flora and reduce regeneration of woody species (Pigott 1983) makes ancient woodlands difficult to identify, but Anderson and Shimwell (1981) consider that several herbs including wood millet *Milium effusum*, yellow archangel *Lamium galeobdolon*, hairy wood rush *Luzula pilosa*, wood anemone *Anemone nemorosa*, woodruff *Galium odoratum* and goldilocks buttercup *Ranunculus auricomus* are indicative of ancient woodland on the shales and boulder clay. Small-leaved lime *Tilia cordata* occurs rarely in some woods and also provides a clue to the identity of the older woods.

METHODS

Snails and slugs were sampled by hand searching in 21 White Peak and 17 Dark Peak woodlands between 1983 and 1987. Leaf litter, dead wood, rock outcrops and scree, tree trunks, living vegetation, wet areas and other microhabitats were examined. In addition, a sample of litter (c. 1.5 L) was collected from each site and examined using a combination of sieving and hand sorting methods. This latter method rarely revealed additional species but two of the most inconspicuous snails, *Punctum pygmaeum* and *Acanthinula aculeata* were occasionally added; these may therefore be under-represented in the samples.

Fig. 1 shows the distribution of the woodlands and Table 1 summarises some of their physical characteristics and floras. The woodlands vary in size but no particular attempt was made to standardise sampling effort. However, all woods were searched for at least 2 hours (often more), and in many cases woods were visited more than once. Sampling was completed in each wood when no additional species were recorded for a reasonable length of time (about 30 minutes) and when all distinct microhabitats had been examined.

Weather conditions were inevitably variable during the survey, but dry spells and the mid-summer and winter months were generally avoided. Sampling efficiency for slugs has been shown to be weather dependent (Cameron 1973), but repeated visits to some sites rarely revealed additional species so the slug records have been included in the analyses. However, the possibility remains that the slug faunas have not been comprehensively recorded.

A detailed analysis of woodland soil was beyond the scope of the study, but at least one soil sample, taken from the top 50 mm, was colourimetrically determined for pH from many of the woods (Table 1). Similarly, complete lists of plants were not compiled for all woods, but the canopy, understorey and ground flora dominants, notable species and notes on stand

age structure were made for most woods. Additional information about the floristics and the histories of some woods has also been obtained from other sources including Pigott (1969), Merton (1970) and Anderson and Shimwell (1981). Information about size, location and altitude has been obtained from the relevant 1:25000 Ordnance Survey sheet.

RESULTS

The species recorded in each wood are given in Table 2. In total, 54 species of terrestrial mollusc were recorded from the woods including two slugs, *Arion hortensis* agg. and *A. ater* agg. which were not determined to species for all sites. Three species found only on limestone, *Pyramidula rupestris*, *Vallonia costata* and *Cecilioides acicula* have been omitted from the following analysis. *Pyramidula rupestris* and *Vallonia costata* appear to be confined to drystone walls which mostly enclose the woodlands. These were not systematically sampled because of their marginal locations. *Vallonia costata* is also more typically a grassland or open habitat species. *Cecilioides acicula* was only detected as dead shells in Cressbrook Dale following a very much more intensive soil sampling programme; it is a subterranean species and may occur more widely in the White Peak woods. *Vertigo pusilla*, which was only found on a wall which runs through Site 37 (Cressbrook Dale) has, however, been retained in the analysis.

Differences between the faunas of the Dark and White Peak woodlands

Total species number (ie. snails plus slugs) is significantly greater in the woods on limestone than in those on millstone grit and shales (Table 3). The total number of snails follows a similar pattern but the total number of slug species does not differ significantly between the Dark and White Peak woodlands. The range in the total number of species is, however, much greater in the Dark Peak class (4–35) than in the White Peak woods (23–35).

Twenty species (5 slugs and 15 snails) are found in significant excess ($P < 0.05$) in the limestone woodlands (Table 4) and nine species, are confined to them. Most of the species which are significantly more frequent in the White Peak woods but which also occur in the Dark Peak woods are almost ubiquitous on the limestone.

Twelve species (4 slugs and 8 snails) are significantly more frequent (Table 4) in the Dark Peak woods than on the limestone, and six of these are confined to them. *Columella aspera*, *Limax tenellus* and *Zonitoides nitidus* were also only found in the Dark Peak woods, but only in one, two and three sites respectively.

Variation within the limestone woodland group

A large number of species are common to many woodlands within this group and 22, 19 and 9 species are present in at least 80%, 90% and 100% of the sites respectively. Soil pH measurements were taken from 15 limestone woodlands but only three sites lay outside the range 6.5–7.5. Mean soil pH does not correlate significantly with either total species number or the total number of snails or slugs taken separately.

Variation within the geological classes has also been examined using Reciprocal Averaging Ordination (Hill 1973), which places the species or sites along artificially constructed axes according to the faunal complement of the sites. Species which occur in fewer than 3 sites have been omitted from this analysis. The ordination products have been rescaled to lie between 0 and 100 and Figs. 2 and 3 show the species and site ordinations respectively.

TABLE 2
The species present in the Dark Peak (Sites 1–17) and White Peak (Sites 18–38) woods

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | |
|---------------------------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|---|
| <i>Carychium minimum</i> | + | + | + | + | + | | + | + | + | + | + | | + | + | + | + | + | | | | | | | | | | + | | | | | | | | | | | | |
| <i>Carychium tridentatum</i> | + | + | + | + | + | + | | + | + | + | | + | | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | |
| <i>Succinea putris</i> | | | + | + | | | + | + | + | | | | | + | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Azeca goodalli</i> | | | | + | | | | + | | | | + | | | + | | + | | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | |
| <i>Cochlicopa lubrica</i> | | | + | + | + | | + | | | | + | + | | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | |
| <i>Cochlicopa lubricella</i> | | | | | | | | | | | | + | | | | | | | | | | | | | | | | | | | | | | | | | | + | |
| <i>Pyramidula rupestris</i> | | | | | | | | | | | | | | | | | | w | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | w | | |
| <i>Columella aspera</i> | | | | | | | + | | | | | | | + | | | | | | | | | | | | | | | | | | | | | | | + | w | |
| <i>Columella edentula</i> | | | + | + | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Vertigo pusilla</i> | | | | | | | | + | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Vertigo substriata</i> | + | + | + | + | + | | | + | + | | | | | + | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Leiostylis anglica</i> | + | + | + | | | | + | + | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Lauria cylindracea</i> | | | | | | | | | | | | | | | | | | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | |
| <i>Vallonia costata</i> | | | | | | | | | | | | + | | | + | | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | w | | |
| <i>Acanthinula aculeata</i> | | + | + | + | + | | | + | + | | | + | | + | | | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | |
| <i>Ena obscura</i> | | | | | | | | | | | + | | | | | | | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | |
| <i>Punctum pygmaeum</i> | + | + | + | | + | | | + | + | | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| <i>Discus rotundatus</i> | + | + | + | + | | | + | + | + | + | + | + | | | | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| <i>Arion flagellus</i> Collinge | | | | | | | | | | | | + | | | | | | | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | |
| <i>Arion ater</i> agg. | + | + | + | + | + | | + | + | + | + | | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | |
| <i>Arion subfuscus</i> | + | + | | | | + | | + | | + | + | + | | | | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| <i>Arion circumscriptus</i> | | | | | | | + | + | | | | | + | + | + | | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| <i>Arion fasciatus</i> | | | | | | | | | | | | | | + | + | | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | |
| <i>Arion silvaticus</i> | + | + | + | + | | | | + | + | + | | + | | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| <i>Arion hortensis</i> agg. | d | | d | + | | | + | d | + | + | | + | | | + | + | + | d | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | d | + | + | + | + | |
| <i>Arion intermedius</i> | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | |
| <i>Vitrina pellucida</i> | + | + | + | + | | | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| <i>Vitrea crystallina</i> | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | |
| <i>Vitrea contracta</i> | + | + | | | | | | + | + | + | | | | + | + | | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| <i>Nesovitreia hammonis</i> | + | + | + | + | + | + | + | + | + | + | + | | + | + | + | | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | |
| <i>Aegopinella pura</i> | + | + | + | + | + | | + | + | + | + | + | | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| <i>Aegopinella nitidula</i> | + | + | + | | | | | + | + | + | | | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| <i>Oxychilus cellarius</i> | + | | | + | | | | | | | | | | + | + | | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| <i>Oxychilus alliarius</i> | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| <i>Oxychilus helveticus</i> | + | + | + | | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| <i>Zonitoides nitidus</i> | | | + | | | | + | + | | | + | + | + | | | + | | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |

TATTERSFIELD: TERRESTRIAL MOLLUSC FAUNAS

[illegible]

d Confirmed as *Arion distinctus* Mabile. w Confined to walls. s Only recorded as dead shells.

TABLE 3

The maximum, minimum, total and mean number of slug and snail species recorded from the White and Dark Peak woodlands

| | White Peak | | | | | Dark Peak | | | | | Prob. |
|--------|------------|-----|-------|-------|------|-----------|-----|-------|-------|------|-------|
| | Max. | Min | Total | Mean | S.E. | Max. | Min | Total | Mean | S.E. | |
| Total | 35 | 23 | 44 | 28.71 | 0.62 | 35 | 4 | 44 | 20.06 | 2.08 | *** |
| Slugs | 11 | 4 | 13 | 7.90 | 0.41 | 12 | 3 | 13 | 7.24 | 0.62 | ns |
| Snails | 25 | 17 | 31 | 20.81 | 0.42 | 24 | 1 | 31 | 12.82 | 1.61 | *** |

A t-test has been used to test the null hypothesis that the means are equal, *** $P<0.001$; ns $P>0.05$.

TABLE 4

The association of each species with the White Peak and Dark Peak woods and constancy values for each species (C%)

| Species | White Peak (Maximum 21) | | Dark Peak (Maximum 17) | | Probability |
|--|----------------------------|-------|---------------------------|-------|-------------|
| | No. | C% | No. | C% | |
| Species which are confined to the limestone woods | | | | | |
| <i>Ena obscura</i> | 21 | 100.0 | 0 | 0.0 | *** |
| <i>Cochlodina laminata</i> | 17 | 81.0 | 0 | 0.0 | *** |
| <i>Lauria cylindracea</i> | 16 | 76.2 | 0 | 0.0 | *** |
| <i>Cochlicopa lubricella</i> | 13 | 61.9 | 0 | 0.0 | *** |
| <i>Helicigona lapicida</i> | 10 | 47.6 | 0 | 0.0 | *** |
| <i>Trichia striolata</i> | 7 | 33.3 | 0 | 0.0 | ** |
| <i>Milax budapestensis</i> | 7 | 33.3 | 0 | 0.0 | ** |
| <i>Vertigo pusilla</i> | 1 | 4.8 | 0 | 0.0 | ns |
| <i>Arion flagellus</i> Collinge | 1 | 4.8 | 0 | 0.0 | ns |
| Species found in significant excess in limestone woods | | | | | |
| <i>Clausilia bidentata</i> | 21 | 100.0 | 3 | 17.6 | *** |
| <i>Cochlicopa lubrica</i> | 21 | 100.0 | 6 | 35.3 | *** |
| <i>Aegopinella nitidula</i> | 21 | 100.0 | 6 | 35.3 | *** |
| <i>Trichia hispida</i> | 20 | 95.2 | 2 | 11.8 | *** |
| <i>Arianta arbustorum</i> | 20 | 95.2 | 4 | 23.5 | *** |
| <i>Oxychilus cellarius</i> | 20 | 95.2 | 4 | 23.5 | *** |
| <i>Vitrea contracta</i> | 20 | 95.2 | 5 | 29.4 | *** |
| <i>Arion hortensis</i> agg. | 20 | 95.2 | 5 | 29.4 | *** |
| <i>Limax maximus</i> | 19 | 90.5 | 4 | 23.5 | *** |
| <i>Arion circumscriptus</i> | 15 | 71.4 | 5 | 29.4 | * |
| <i>Cepaea hortensis</i> | 12 | 57.1 | 1 | 5.9 | ** |
| <i>Cepaea nemoralis</i> | 8 | 38.1 | 2 | 11.1 | * |
| <i>Arion fasciatus</i> | 8 | 38.1 | 1 | 5.9 | * |
| Species without significant affinity | | | | | |
| <i>Carychium tridentatum</i> | 21 | 100.0 | 14 | 82.4 | ns |
| <i>Discus rotundatus</i> | 21 | 100.0 | 13 | 76.5 | ns |
| <i>Vitrea crystallina</i> | 21 | 100.0 | 16 | 94.1 | ns |
| <i>Oxychilus alliarius</i> | 21 | 100.0 | 17 | 100.0 | ns |
| <i>Limax marginatus</i> | 21 | 100.0 | 14 | 82.4 | ns |
| <i>Vitrina pellucida</i> | 20 | 95.2 | 12 | 70.6 | ns |
| <i>Aegopinella pura</i> | 19 | 90.5 | 13 | 76.5 | ns |
| <i>Euconulus fulvus</i> | 19 | 90.5 | 14 | 82.4 | ns |
| <i>Arion ater</i> agg. | 18 | 85.7 | 14 | 82.4 | ns |
| <i>Arion silvaticus</i> | 18 | 85.7 | 11 | 64.7 | ns |

TATTERSFIELD: TERRESTRIAL MOLLUSC FAUNAS

TABLE 4 continued

| Species | White Peak (Maximum 21) | | Dark Peak (Maximum 17) | | Probability |
|--|----------------------------|------|---------------------------|-------|-------------|
| | No. | C% | No. | C% | |
| <i>Acanthinula aculeata</i> | 17 | 81.0 | 8 | 47.1 | ns |
| <i>Deroceras reticulatum</i> | 16 | 76.2 | 9 | 52.9 | ns |
| <i>Punctum pygmaeum</i> | 13 | 61.9 | 9 | 52.9 | ns |
| <i>Azeca goodalli</i> | 4 | 19.0 | 1 | 5.9 | ns |
| <i>Oxychilus helveticus</i> | 4 | 19.0 | 1 | 5.9 | ns |
| <i>Columella edentula</i> | 3 | 14.3 | 3 | 17.6 | ns |
| Species found in significant excess in the gritstone/shale woods | | | | | |
| <i>Arion intermedius</i> | 13 | 61.9 | 17 | 100.0 | ** |
| <i>Limax cinereoniger</i> | 6 | 28.6 | 14 | 82.4 | ** |
| <i>Nesovitrea hammonis</i> | 4 | 19.0 | 11 | 64.7 | * |
| <i>Arion subfuscus</i> | 4 | 19.0 | 10 | 58.8 | * |
| <i>Zenobiella subrufescens</i> | 1 | 4.8 | 7 | 41.2 | ** |
| <i>Carychium minimum</i> | 1 | 4.8 | 14 | 82.4 | *** |
| Species which are confined to the gritstone/shale woods | | | | | |
| <i>Deroceras laeve</i> | 0 | 0.0 | 13 | 76.5 | *** |
| <i>Vertigo substriata</i> | 0 | 0.0 | 9 | 52.9 | *** |
| <i>Succinea putris</i> | 0 | 0.0 | 5 | 29.4 | * |
| <i>Zonitoides excavatus</i> | 0 | 0.0 | 5 | 29.4 | * |
| <i>Euconulus alderi</i> | 0 | 0.0 | 5 | 29.4 | * |
| <i>Leiostyla anglica</i> | 0 | 0.0 | 4 | 23.5 | * |
| <i>Zonitoides nitidus</i> | 0 | 0.0 | 3 | 17.6 | ns |
| <i>Limax tenellus</i> | 0 | 0.0 | 2 | 11.8 | ns |
| <i>Columnella aspera</i> | 0 | 0.0 | 1 | 5.9 | ns |
| * $P<0.05$ | | | | | |
| ** $P<0.01$ | | | | | |
| *** $P<0.001$ | | | | | |
| ns $P>0.05$ | | | | | |

The species ordination (Fig. 2) illustrates the high degree of similarity among the faunas of the White Peak woodlands. Most species cluster tightly together and few account for the differences between sites. The sites show little immediately obvious sign of clustering (Fig. 3), but both axes correlate significantly with one or more of the physical or geographical characteristics of the sites (Table 1). The first axis correlates significantly with distance eastwards ($r=0.717$; 19 d.f.; $P<0.001$), and negatively with mean altitude ($r=-0.652$; 19 d.f.; $P<0.01$). The more eastern sites also tend to be lower in mean altitude ($r=-0.712$; 19 d.f.; $P<0.001$). Partial correlations indicate that fixing eastness reduces the correlation to insignificance, thus suggesting that the axis is more closely related to geographical position than elevation. The second axis is negatively related to the total number of snails ($r=-0.563$; 19 d.f.; $P<0.01$), and both distance northwards ($r=-0.518$; 19 d.f.; $P<0.05$) and eastwards ($r=-0.517$; 19 d.f.; $P<0.05$). The latter two of these are unrelated ($r=0.047$; 19 d.f.; $P>0.1$). Total species number (ie. snails plus slugs) does not correlate significantly with any factor, but there is a trend for the more eastern faunas to contain more snails ($r=0.612$; 19 d.f.; $P<0.01$).

Although the limestone woodlands are scattered throughout the study region, most of them are associated with one of the major river valleys. The correlations with geographical position hint at several loose geographical groupings which can be more broadly related to the river valleys. The south-western sites in the Hamps and Manifold valley ordinate relatively close to each other. These sites are characterised in particular by a high frequency of *Limax cinereoniger* and the absence of *Helicigona lapicida*.

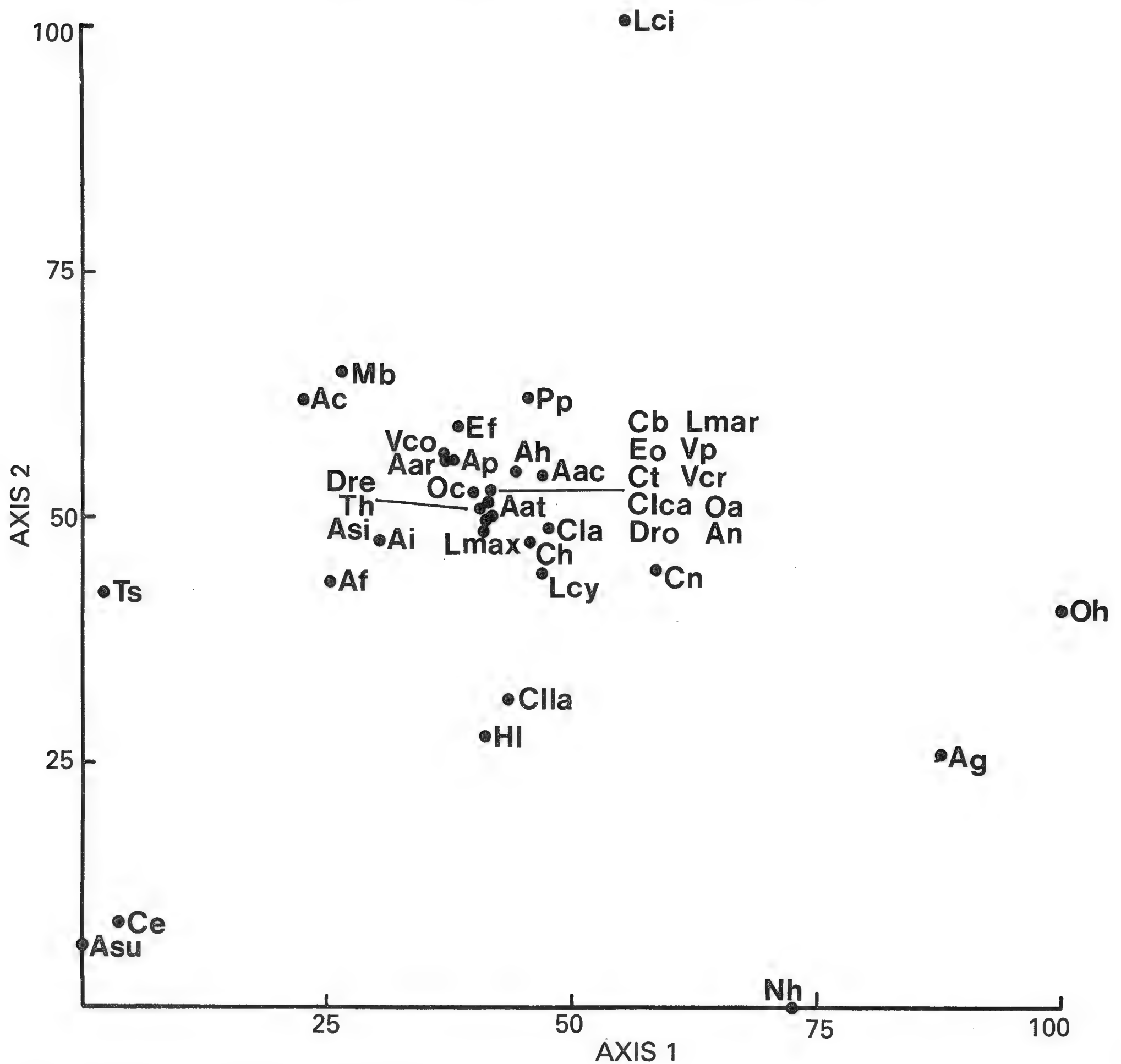


Fig. 2. Ordination of the White Peak species

The species are identified by unique codes starting with the first letter of the generic name.

The easternmost sites all rank highly on the first axis, and may represent another cluster. These woodlands are situated at relatively low altitude along the River Derwent valley or its branch valleys. *Oxychilus helveticus* is confined to these four sites and *Azeca goodalli* is also more frequent in them than elsewhere.

Most of the remaining sites are located either on the slopes of the River Wye valley or in dales which branch off it to the north. The variation in faunal composition within these sites is more diffuse, but *Arion subfuscus* and *Columella edentula* are confined to them, and *Cochlicopa lubricella*, *Helicigona lapicida* and *Arion fasciatus* are perhaps more frequent in them than elsewhere. *Limax cinereoniger* occurs in Taddington Wood (28) which lies adjacent to the main Wye valley.

Variation within the gritstone and shale woodland group

Only 9 species occur in more than 80% of the sites in this group and only two, *Arion intermedius* and *Oxychilus alliarius* were found in them all. Soil pH varies considerably amongst

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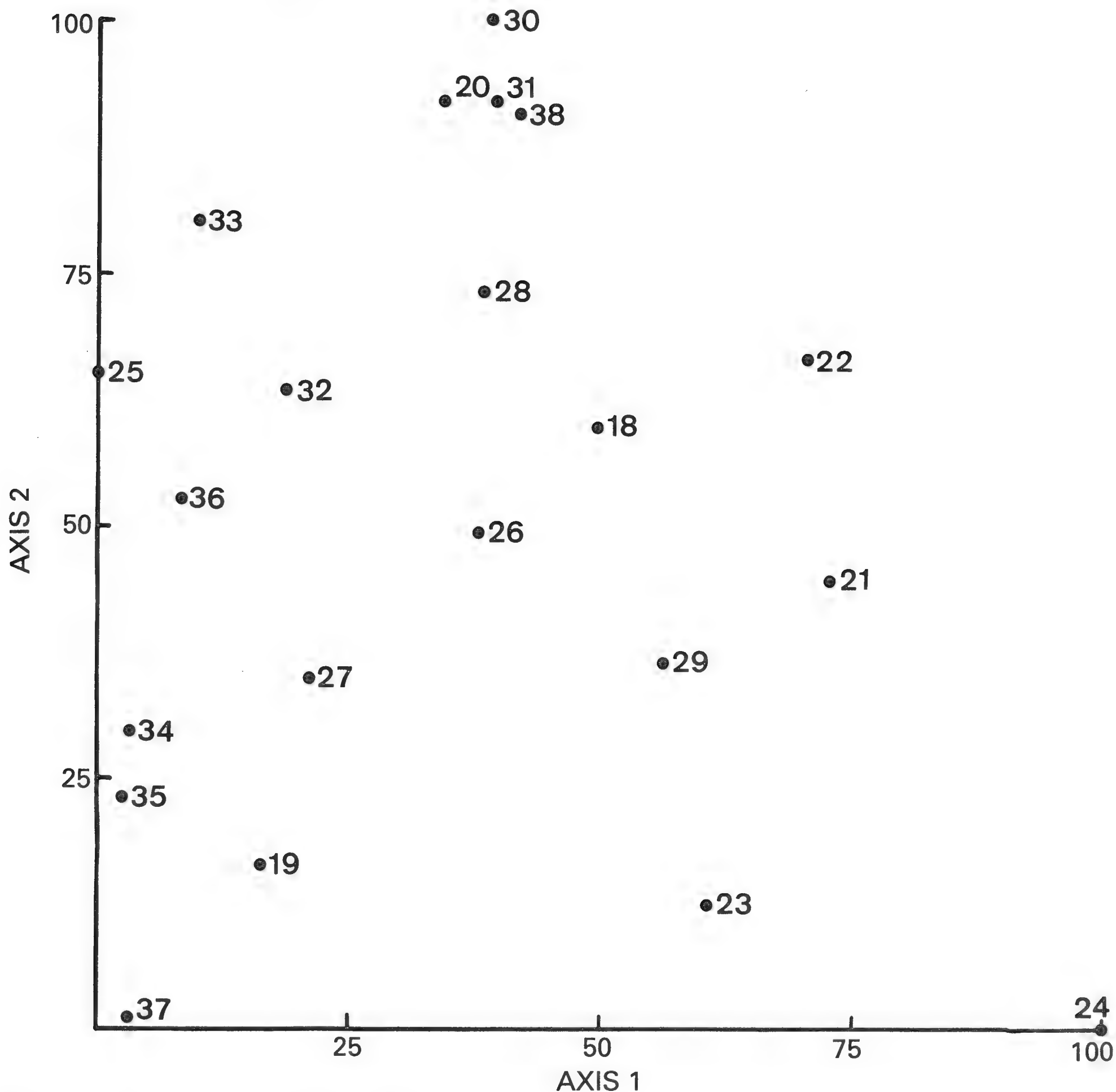


Fig. 3. The ordination of the White Peak sites.

the 17 woods sampled with an overall range of 4.0 to 7.5. Many woods are also internally very variable for soil pH. For example, the three pH measurements from Clough Wood (Site 3) range from pH 4 to 6.5. Given this heterogeneity it is perhaps not surprising that total species number does not correlate strongly with either maximum ($r=0.583$; 9 d.f.; $P>0.05$) or mean ($r=0.409$; 9 d.f.; $P>0.05$) soil pH. Neither the number of slugs nor snails separately correlate significantly with soil pH.

The ordination of the Dark Peak Woods is shown in Fig. 4. The first axis correlates most strongly with species number ($r=0.858$; 15 d.f.; $P<0.001$) but it is also negatively related to altitude ($r=-0.620$; 15 d.f.; $P<0.01$). Mean altitude and species number are negatively correlated ($r=-0.600$; 15 d.f.; $P<0.05$) indicating that fewer species are present at higher sites. It was clear during sampling that the number of species supported by any individual Dark Peak wood was greatly affected by the occurrence and frequency of damp areas, marshes or flushes, and axis 1 may also reflect this factor. Ladybower Wood (13), which scores zero on axis 1, was the only totally dry woodland sampled and it provides an example of the dry woodland mollusc assemblage which occurs more widely in many of the dry areas

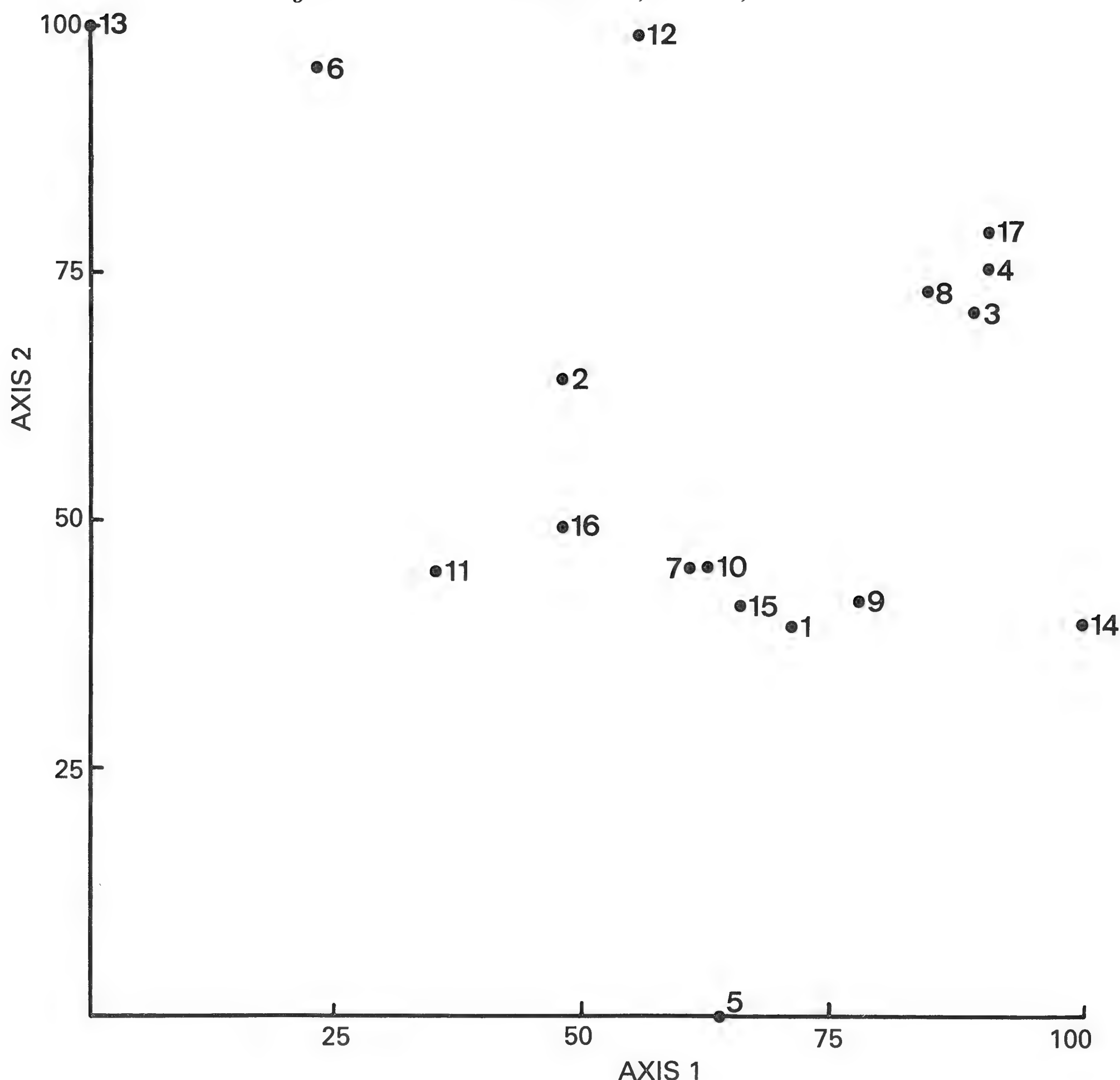


Fig. 4. Ordination of the Dark Peak sites

of the other Dark Peak woods. Wet areas are often associated with shale strata, and have distinctive plant communities: alder typically dominates the canopy, occasionally with ash, and the ground flora supports species such as marsh hawksbeard *Crepis paludosa*, meadow-sweet *Filipendula ulmaria*, *Chrysosplenium oppositifolium*, bugle *Ajuga reptans*, angelica *Angelica sylvestris* and yellow pimpernel *Lysimachia nemorum*. The second ordination axis only correlates weakly with distance eastwards ($r=0.561$; 15 d.f.; $P<0.05$).

The ordination of the Dark Peak species (Fig. 5) shows that there is much more variation than in the White Peak fauna. No distinct clusters are apparent but species which are most tolerant of acidic/base-poor conditions rank at low positions on axis 1 whereas some of the more calcicolous species, which are more frequent in the White Peak, score highly. The second axis appears to reflect the dampness of the habitat, or at least pick out mollusc assemblages which are associated with the damp areas and their associated mull humus soils. Wetland species have low scores on this axis. *Zonitoides excavatus*, which occurs typically with few other species in relatively dry, acidic oak-birch woodland rates high on axis 2 but low on axis 1.

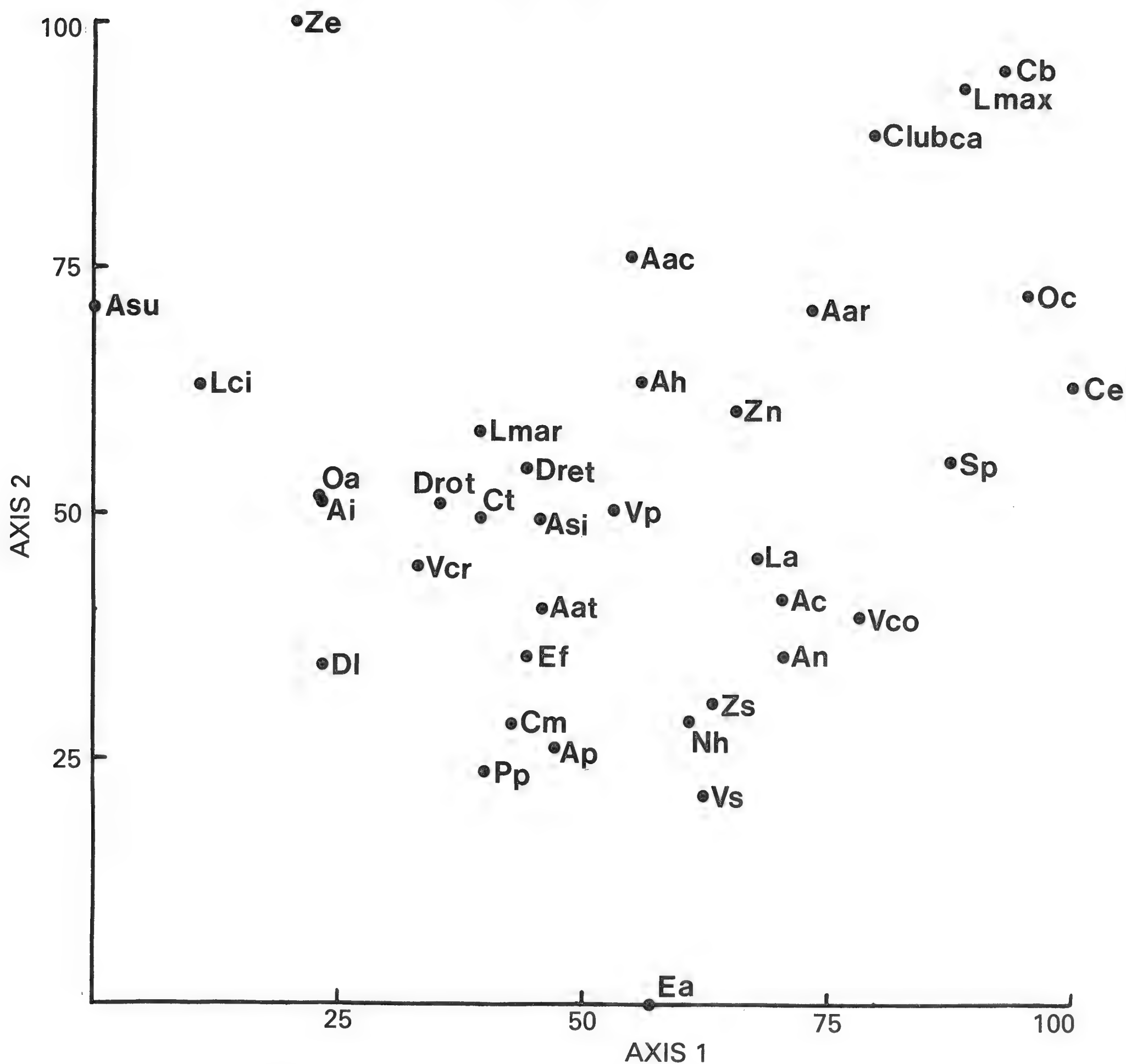


Fig. 5. Ordination of the Dark Peak species

The faunas in relation to the status and origins of the woodlands

Many of the woods are shown on the 1st Edition of 1:25000 Ordnance Survey maps of the region (circa 1840) and most of these have been included in the Nature Conservancy Council's Inventory of Ancient Woodland. However, the origins, status and land use histories of the woodlands are very complex and a full assessment of these factors for all the woodlands in this study is not feasible. Pigott (1969) lists ten of the limestone woodlands sampled here (Sites 19–24, 27, 30, 37 and 38) as having at least one of the characteristics of the older woodland type of the dales. A comparison of the snail and slug species which occur in these, as opposed to the other 11 White Peak woods, does not reveal any strong associations and none of the species have a significant affinity for either group. However, it needs to be appreciated that the status of different areas of the woods varies considerably and some of the other woods, such as parts of Great Shacklow Wood (Site 29), may contain regions of ancient woodland (Merton 1970).

The problems associated with identifying the ancient Dark Peak woods are even more acute and this makes a similar analysis to that undertaken above impossible. In addition,

many of the plants which are reputed to be indicative of ancient sites are associated with the damp, mull humus soils which also support the most diverse snail faunas. This correlation means that it is not possible to make an independent assessment of these factors, at least from these data.

DISCUSSION

The total number of species recorded from the Dark and White Peak woodlands is identical but there are major differences in the composition and structure of the faunas which mostly reflect the degree of internal variability in the woods in these two classes. The limestone woods support relatively homogeneous faunas with comparatively little variation in either total species number or the suite of species. A large number of species are widespread and few species, notably *Azeca goodalli*, *Limax cinereoniger* and *Oxychilus helveticus*, seems to account for the geographical differences. Differences in soil pH among the White Peak woods are also apparently minor and observations made during sampling suggests that the distribution of species appears to be relatively uniform throughout them. However, there are some exceptions such as *Pyramidula rupestris*, *Vertigo pusilla* and *Helicigona lapicida* which are generally associated with rock outcrops or stone walls and *Milax budapestensis* and also possibly *Trichia striolata* which appear to be most frequent in parts of the woods which had been disturbed by people, especially where quantities of rubbish have accumulated or at the woodland edges near roads. Such associations with human disturbance have been described by Boycott (1934) and Kerney and Stubbs (1980). In the Dark Peak woods, it appears to be the species which are significantly more frequent in the White Peak woods, such as *Limax maximus*, *Clausilia bidentata*, *Trichia hispida* and *Cepaea* spp., which are associated with areas of disturbance.

The faunas of the Dark Peak woods are strikingly different in character. There is great variation in species number among the woods and relatively few species are widespread. The calcifuge *Zonitoides excavatus* occurs in five woods but overall they are characterised by the presence of the hygrophilous *Leiostryla anglica*, *Vertigo substriata*, *Zonitoides nitidus*, *Succinea putris*, *Deroceras laeve*, *Carychium minimum* and *Euconulus alderi* (Boycott 1934). All these species also occur in open, unwooded habitats such as marshes and flushed areas on moorland in the Dark Peak. Internally, the Dark Peak woods are very heterogeneous with areas of dry woodland, typically dominated by oak and birch, containing species-poor assemblages (viz Ladybower Wood, Site 13) but rich faunas along stream valleys, on flushed soils and in marshy areas. The heterogeneity is reflected in the plant communities and the very variable soil pH. Relationships between mollusc diversity or numbers and pH are not direct, available calcium levels, especially in litter, being more relevant (Wäreborn 1969). It is likely that a sampling programme with a fine resolution and greater analysis of soil chemistry would reveal faunas which were more closely related to litter and soil characters. Other factors such as the physical structure of the soil or the presence of deep leaf litter beds may also be important for some species.

Boycott (1934) classified many of the characteristic species on the White Peak woods as obligatory calcicoles and several of the Dark Peak specialists as hygrophiles. The affinities of some of the slug species are more unexpected. The two large limacids *Limax cinereoniger* and *Limax maximus* are negatively associated ($P < 0.001$) and are characteristic of the Dark and White Peak woods respectively, although there is some overlap and four limestone woods and three Dark Peak woods support both species. *Arion circumscriptus* and *A. fasciatus* are both associated with the limestone woods whereas *A. silvaticus* shows no marked preference. The pattern for these three *Arion* species is in general accordance with the threshold pH values for slugs in south west Sweden (Waldén 1981).

The ordinations of the White and Dark Peak woodlands separately, suggest that the variation within them is more complex and that it has different origins in each geological class. Thus, although the faunas of the White Peak woodlands are characterised by calcicolous species, the differences among them cannot be readily ascribed to soil pH. Geographical position and altitude, presumably mediated by climatic factors, appears to affect most strongly their composition but there appear to be very few species involved in the differences. The western sites (ie. especially those along the Dove, Hamps and Manifold valleys) presumably have a more atlantic climate and *Limax cinereoniger*, which is predominantly a western species in the British Isles (Kerney and Cameron, 1979; Kerney, 1976), is most frequent in them. Shimwell (unpublished) notes that these Staffordshire limestone woods have an affinity with the more oceanic oak woodlands of western Britain. It has been suggested that *Limax cinereoniger* is associated with ancient woodland in Britain (Boycott 1934, Kerney and Stubbs 1980) and several of the woods containing this species have features which indicate that they are ancient, including mixed shrub communities, limes *Tilia* spp. and the presence of several woodland herbs of restricted distribution. *Limax cinereoniger* may therefore show some association with the ancient woodlands on the limestone, but other limestone sites studied (eg. Cressbrook Dale, Matlock Woods) which have similar characteristics do not contain this slug. The ubiquity of *Limax cinereoniger* in the damper Dark Peak woods may indicate that its distribution is more closely related to humidity, ground water or precipitation.

Four of the other Dark Peak woodland specialists, *Leiostyla anglica*, *Vertigo substriata*, *Zenobiella subrufescens* and *Limax tenellus* are also reputed to be associated with ancient woodland (Kerney & Stubbs 1980, Boycott 1934). If such an association exists for the first two species, it does not appear to be strong because both also occur in unwooded marshes and flushes in the Dark Peak, *Vertigo substriata* being frequent in such habitats, both here and elsewhere (Kerney & Cameron 1979). However, it is possible that these species are indicative of stable and/or undisturbed habitats. *Zenobiella subrufescens* and *Limax tenellus* are both confined to woodland in the area and may have some affinity with ancient sites. Both species occur together in Abney Clough (1) and Shining Cliff Woods (8) and both these sites also support plant species which are indicative of ancient woodland, the latter including small-leaved lime *Tilia cordata*. However, since sites which are known to be recent plantations have not been sampled and there are apparent correlations between soils, rich mollusc faunas and plant communities, the value of these species as indicators cannot be firmly established.

A COMPARISON WITH OTHER WOODLANDS IN THE BRITISH ISLES

Cameron (1978) gives a list of species from limestone woodlands around Malham, Yorkshire in the north Pennines and I have sampled several semi-natural woodlands in the Mendip Hills, Avon and Somerset and one woodland in the Burren, Clare, Eire (Tattersfield, unpublished). The species which occur in these Carboniferous limestone woods, but are absent from the White Peak woods are listed in Table 5.

Five of these species have restricted distributions in the British Isles and are not expected in the study region because of its geographical position. *Helix aspersa* occurs in woodland in the Mendips and southern England generally but personal observations indicate that it is rare and confined to gardens and other areas influenced by man in the south Pennines; it also occurs in the Malham area (Cameron 1978) and may follow a similar association there. *Milax sowerbyi* is also a synanthropic species but I have not recorded it in the south Pennine

TABLE 5

Species which have been recorded from woodlands on Carboniferous limestone elsewhere in the British Isles but are absent from the White Peak Woodlands

| | Mendips | Malham ¹ | Burren |
|--|---------|---------------------|--------|
| <i>Pomatias elegans</i> ² | + | | |
| <i>Acicula fusca</i> | | | + |
| <i>Columella aspera</i> | | | + |
| <i>Vertigo substriata</i> | | | + |
| <i>Abida secale</i> ² | + | + | |
| <i>Leiostyla anglica</i> | | | + |
| <i>Spermodea lamellata</i> | | | + |
| <i>Vitrea subrimata</i> ² | | + | |
| <i>Milax sowerbyi</i> | + | | |
| <i>Macrogastera rolphii</i> ² | + | | |
| <i>Clausilia dubia</i> ² | | + | |
| <i>Balea perversa</i> | + | + | + |
| <i>Ashfordia granulata</i> | + | + | |
| <i>Helix aspersa</i> | + | | |

¹ Four old rocky woods on limestone from Table 1 in Cameron (1978).

² Species that are not expected in the south Pennines area because of their restricted distributions in the British Isles. There are records for *Abida secale* from the South Pennines, but none for many years.

area and Cameron (1978) does not list it for Malham. *Balea perversa* occurs in woodlands in all three areas of the other areas of Carboniferous limestone but it is rare in the Peak District and has not been recorded from woodland in the current study. Many parts of the study region have an impoverished epiphytic lichen flora because of atmospheric pollution (Gilbert 1985) and the whole area falls into pollution zones 0–5 (Hawksworth & Rose, 1976, Dobson 1979). Holyoak (1978) has shown how *Balea* has decreased greatly in areas that have suffered such atmospheric pollution and this may, in part, account for its rarity. Given this known pollution, and consequent acid rain, the comparative richness of some of the Dark Peak woods is relatively reassuring, in contrast with the situation in Scandinavia (Gärdenfors 1987).

Given its geographical position, it is not surprising that the Burren woodland supports a fauna with a strong oceanic element, with species that have a marked western distribution in the British Isles such as *Zenobiella subrufescens* and *Leiostyla anglica*. *Vertigo substriata* and *Leiostyla anglica* which behave as obligatory hygrophiles in the study area occur in this Irish woodland, despite the absence of marshy areas, streams or standing water. Indeed these, and many of the other species recorded from the Burren woodland can be found in the open, on limestone pavement closeby.

Only two species, *Cecilioides acicula* and the nationally uncommon *Vertigo pusilla* were recorded from the White Peak woods but do not appear to occur in any of the Mendips, Malham area or Burren. However, it needs to be appreciated that the number of woods sampled in the other areas is small so rare species may have been missed. *Cecilioides* is also difficult to locate because of its subterranean habit.

The affinities of the Dark Peak woodlands are less easily established because acidic woodlands have generally been less well studied. Bishop (1977) recorded 42 species from eleven acid woodland sites in West Cork and Kerry, Eire and found *Arion intermedius*, *Columella aspera*, *Discus rotundatus*, *Nesovitrea hammonis*, *Oxychilus alliarius* and *Zonitoides excavatus* to be the most widespread and abundant; species number ranged from 9 to 26 (mean=15.6). A similar pattern is found in the Dark Peak woods but *Discus rotundatus*, *Zonitoides excavatus* and *Columella aspera* are less frequent. Bishop's (1977) Irish woods contained several species

not recorded from the Dark Peak including the slugs *Arion lusitanicus* Mabille and *Geomalacus maculosus* which both have strong western distributions in Britain (Kerney 1976), the synanthropic slugs *Deroceras caruanae* and *Milax budapestensis*, and the snails *Balea perversa*, *Ashfordia granulata*, *Semilimax pyrenaicus* and *Spermodea lamellata*. Both *Geomalacus* and *Semilimax pyrenaicus* are confined to Ireland in the British Isles (Kerney 1976). Bishop (1976) recorded 43 species from woodlands in Somerset, of which he classified four as base poor woodlands. These woods supported a similar basic fauna to the Dark Peak woodlands but they lacked most of the wetlands snails which differentiate the Dark and White Peak Woods in this study. The only species which they contained which was not recorded in the current study was the slug *Arion lusitanicus*.

Wäreborn (1969) recorded 42 species from five types of lime-free woodland in Southern Sweden with the number of species occurring on his 10×20 metre plots (approx.) ranging from 3 to 25. Thirteen of these species were not recorded from the South Pennine woods but five of them are not present in Britain and a further two only occur outside the study area in Britain. *Nesovitrea hammonis*, *Euconulus fulvus*, *Columella aspera* and *Vertigo substriata* had high constancy values in all of the Swedish woodland types, with *Punctum pygmaeum*, *Cochlicopa lubrica*, *Clausilia bidentata*, *Discus rotundatus*, *Cepaea hortensis* and the non-British *Nesovitrea petronella* occurring frequently on the mixed woodlands with higher pH and higher levels of available calcium. Some of Wäreborn's richer lime-free woodlands supported *Cochlicopa lubricella*, *Cochlodina laminata* and *Helicigona lapicida* which are confined to the limestone sites in the South Pennines.

The conservation value of the faunas

Most of the species recorded during the study are common and widespread in suitable habitats throughout much of the British Isles but some have more restricted distributions or are generally uncommon; these hold some nature conservation interest. *Vertigo pusilla* and *Limax tenellus* are the two most uncommon species and both are classified as Notable (defined as species which occur in fewer than 100 10×10 km squares) by the Nature Conservancy Council. The former of these is most common in southern Cumbria but it is very scattered in southern Britain and probably declining. *Limax tenellus* is a widely distributed but very local slug in Britain. Several of the characteristic species of the richer Dark Peak woodlands, including *Leiostyla anglica*, *Zenobiella subrufescens* and to a lesser extent *Vertigo substriata*, *Zonitoides excavatus* and *Limax cinereoniger* are local and primarily northern and/or western species in Britain. They are less common or only represented in widely scattered, relict sites further to the south and east (Kerney, 1979). The south Pennine uplands represent the edges of these species' major distributions and they therefore need to be regarded as of conservation importance, especially on sites where they occur together. Britain also represents the major strongholds for *Zenobiella subrufescens*, *Leiostyla anglica* and, to a lesser extent, *Zonitoides excavatus* in Europe. Only *Helicigona lapicida* can be regarded as of a wider significance among the White Peak woodland specialists because it has only a scattered distribution throughout much of southern England and also because the Peak District and Craven Pennine limestone areas represent strongholds for it in Britain.

ACKNOWLEDGEMENTS

I am grateful to Dr R. A. D. Cameron for comments and suggestions on a draft of this paper and to B. C. Eversham who kindly identified some of the slugs. Some of the survey work for this project was undertaken while I was employed by the Nature Conservancy Council. I am

also grateful to Penny Anderson Associates, Consultant Ecologists, for computer facilities and to D. Tattersfield for assistance with computer programming.

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PROCEEDINGS OF THE CONCHOLOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND

REPORT OF COUNCIL

It is with regret that we report the death of the following Members of the Society.

Mr. H. Lomas who joined the Society in 1977, Dr. B. Prashad who joined in 1923, Dr. G. A. Solem, a member since 1961, Dr. T. E. Thompson, a member since 1975 and Dr. W. S. S. van der Seen who joined in 1924.

TREASURER'S REPORT, 1989

This year the accounts show a loss of £1 615 almost entirely due to increases in printing costs.

There was a small decrease in Members' and Subscribers' payments. Investment income increased slightly due to income from £10 000 National Savings Income Bonds. The ICI loan was repaid and the Society's holdings of 5% Treasury Stock matured yielding capital gains of £43.51 and £56.00 respectively.

The Society's subscription rate was increased for 1990, however, it is unlikely that the new rate can be held for more than a couple of years due to increasing costs. 21 Ordinary Members and 5 Junior Members were still in arrears for 1988 and an additional 35 Ordinary and 2 Junior Members were in arrears for 1989. There are now no paid up Junior Members. The bank now charges £6.50 for changing foreign currency cheques. Would all overseas Members please arrange to pay in Sterling or adjust their remittances to cover conversion costs.

A. SECCOMBE
(Hon Treasurer)

RECORDER'S REPORT: MARINE MOLLUSCA

Mr. D. J. Howlett reports the first occurrence in England of the North American razor shell *Ensis americanus* (Binney). He has found many empty shells washed ashore at several places along the North Norfolk coast (sea area S12), and the identification has been confirmed by Dr. van Urk who, in 1987, predicted that the species may soon spread from the German Bight and Dutch coast (*J. Conch. Lond.* 32, pp. 329-333).

Among many interesting records arising from a Conchological Society field trip to County Donegal in Eire (sea area S33) in June 1989 (J. D. Nunn, in press), the most surprising was that of several specimens of the chiton *Leptochiton scabridus* (Jeffreys) under boulders on the lower shore. This species is normally sublittoral and endemic to Southwest England, the Channel Islands and Brittany (Kaas and van Belle, 1985, *Monograph of Living Chitons*, vol. 1, Leiden), and the record represents a northward extension of range of some six hundred kilometres. Dr. J. M. Baxter was present as a member of the field trip, and was able to confirm the identity.

INCOME AND EXPENDITURE ACCOUNT

| | YEAR ENDED 31 DECEMBER 1989 £ | YEAR ENDED 31 DECEMBER 1988 £ |
|--|-------------------------------------|-------------------------------------|
| INCOME | | |
| Fees and subscriptions | 9,075.10 | 9,433.75 |
| Investment income | 3,162.81 | 2,949.53 |
| Donations | 563.29 | 240.59 |
| Sales | 239.25 | 386.45 |
| Gain on repayment of investments | 99.51 | — |
| Sundry income | 25.00 | 10.00 |
| | <hr/> | <hr/> |
| | 13,164.96 | 13,020.32 |
| EXPENDITURE | | |
| Journal | 8,738.00 | 6,646.00 |
| Newsletter | 4,402.23 | 3,795.60 |
| Stationery and postage | 977.05 | 766.27 |
| Members' list | 687.17 | 695.10 |
| Meetings | 480.00 | 480.00 |
| Sundry | 359.34 | 618.93 |
| | <hr/> | <hr/> |
| | (15,643.79) | (13,001.90) |
| Excess of income over expenditure | (2,478.83) | 18.42 |
| Transfer (to)/from Reserves (Reserve and Research Fund) | 973.81 | (443.72) |
| (Life Members' Fund) | (110.00) | — |
| | <hr/> | <hr/> |
| | (1,615.02) | (425.30) |
| | <hr/> <hr/> | <hr/> <hr/> |

PROCEEDINGS

BALANCE SHEET

| | YEAR ENDED 31 DECEMBER 1989 £ | YEAR ENDED 31 DECEMBER 1988 £ |
|-------------------------------|-------------------------------------|-------------------------------------|
| ASSETS | | |
| Investments | 17,662.51 | 20,402.60 |
| Cash | 6,022.35 | 6,167.74 |
| | <hr/> | <hr/> |
| | 23,684.86 | 26,570.34 |
| LIABILITIES | | |
| Creditors and accrued charges | 2,072.73 | 1,723.88 |
| Advance subscriptions | 766.00 | 1,521.50 |
| Life members fund | 3,000.00 | 2,890.00 |
| Reserve and research fund | 2,976.08 | 3,949.89 |
| | <hr/> | <hr/> |
| | 8,814.81 | 10,085.27 |
| | <hr/> | <hr/> |
| | 14,870.05 | 16,485.07 |
| | <hr/> <hr/> | <hr/> <hr/> |
| Represented by: | | |
| CAPITAL ACCOUNT BROUGHT FOR- | | |
| WARD | 16,485.07 | 16,910.37 |
| LOSS FOR THE YEAR | (1,615.02) | (425.30) |
| | <hr/> | <hr/> |
| | 14,870.05 | 16,485.07 |
| | <hr/> <hr/> | <hr/> <hr/> |

A. D. Seccombe Honorary Treasurer

A. N. Light FCA
D. Worth
Honorary Auditors

Reports of *Patella depressa* Pennant from Ireland have been regarded with suspicion, but limpets found in 1989 by I. Killeen and J. Light on the Galway coast (sea area S36) 'accord so closely with those regularly found at various sites in Sea Area 15 (Wight) and which we believe to be *depressa*, we have chosen to call them *P. depressa* also' (*Conchologists' Newsletter* 111, pp. 242–245). Further work is needed to clarify the identity of these limpets. Killeen and Light also found a live *Graphis albida* (Kanmacher) in Galway Bay, only the second post-1950 live record of this minute prosobranch (see *J. Conch. Lond.* 32, p. 386).

Two rare nudibranchs have been reported: *Atagema gibba* Pruvot-Fol in Cornwall, by Alan Mildrom (the second for sea area S18 Cornwall, and the third for Britain), and *Hancockia uncinata* (Hesse) from Donegal Bay (sea area S34) by Julia Nunn, being the fourth post-1950 British-and-Irish record.

I am indebted to Dr. D. J. Basford and the Department of Agriculture and Fisheries for Scotland for extensive detailed information on 'disc' on the infauna and epifauna from many stations in the North Sea, from the Shetlands to the Firth of Forth, and across to Norwegian and Danish coastal waters. This is derived from survey work recently published in *J. mar. biol. Ass. U.K.* (1989) 68, pp. 123–143 and 387–407.

It is with great regret that I have to report the death of Dr. T. E. Thompson, a foremost figure in the study of opisthobranchs, who contributed much to the recording scheme, and was for a time area representative for sea area S21 Bristol Channel.

D. R. SEAWARD

RECORDER'S REPORT: NON-MARINE MOLLUSCA

The following new vice-comital records have been authenticated since the last Report (*J. Conch., Lond.* 33, p. 264). All date from 1989–90 unless stated otherwise.

Cornwall West (1): *Anodonta cygnea*, College Reservoir, Penryn (10/7633), J. Millett.

Devon South (3): *Ferrissia wautieri*, Paignton Zoo (20/8759); *Toltecia pusilla*, Dawlish Warren (20/9878), both D. E. Bolton.

Devon North (4): *Planorbarius corneus*, Benworthy (21/4502; farm pond), G. de Bethune.

Sussex West (13): *Arion flagellus*, Codmore Hill (51/0520), Miss S. M. Davies, 1988.

Surrey (17): *Hygromia cinctella*, Ewell (51/2262; garden), B. Verdcourt.

Essex North (19): *Ferrissia wautieri*, Waltham Abbey (52/3800), Mrs E. B. Rands and D. W. Guntrip, 1988.

Herts (20): *Menetus dilatatus*, Cheshunt (52/3602), Mrs E. B. Rands and D. W. Guntrip, 1988.

Norfolk West (28): *Pisidium hibernicum*, Gressenhall (53/9716), M. Kerney, 1970.

Gloucester West (34): *Arion flagellus*, *Boettgerilla pallens*, Mitcheldean (32/6616), D. C. Long; *Hygromia cinctella*, Blaise Castle, Henbury (31/5577), R. D. Hawkins.

Anglesey (52): *Vertigo lilljeborgi*, Cors Erddreiniog (23/4782), D. C. Boyce, 1988.

Nottingham (56): *Arion lusitanicus*, Beeston (43/5336; garden), D. T. Holyoak, 1984.

Chester (58): *Ferrissia wautieri*, Burton (33/3375), I. D. Wallace.

York North-west (65): *Boettgerilla pallens*, Hudswell (45/1500); *Zenobiella subrufescens*, Hudswell (45/1400), both L. Lloyd-Evans.

Durham (66): *Arion owenii*, Durham (45/2945), N. Jackson, 1979.

Perth Mid (88): *Anisus leucostoma*, Killin (27/5834), Mrs D. K. Marriott.

Kintyre (101): *Acroloxus lacustris*, Lochan Taynish (16/7385), Mrs D. K. Marriott.

Ross East (106): *Zonitoides excavatus*, Loch Achilty (28/4356), E. Kellock, 1973.

Sutherland East (107): *Zonitoides excavatus*, Golspie (29/80), old collection, BMNH.

Clare (H9), *Catinella arenaria*, Lough Bunny (11/3897), B. Colville.
Mayo West (H27): *Cerņuella virgata*, Dooaghtry (02/7468), P. Tattersfield.

The above finds include several of interest. Perhaps the most important is a new site (Lough Bunny, Co. Clare) for the rare succineid *Catinella arenaria*. It lives here in a limestone grassland subject to flooding and dominated by *Schoenus nigricans*. It is also worth putting on record that a population at Dooaghtry in West Mayo (H27; 02/7469), discovered in 1909 and last seen in 1942, was relocated in 1989 by Dr Peter Tattersfield. *C. arenaria* must nevertheless be regarded as an endangered species.

Vertigo lilljeborgi was found in a calcareous marsh in Anglesey. This forms a link between the sites in the Lake District and scattered relict populations further south in Wales (Carmarthen, Cardigan, Merioneth, Caernarvon).

The tiny Mediterranean snail *Toltecia pusilla* (syn. *Punctum pusillum*) was first reported from Britain in 1986 (*J. Conch., Lond.* **32**, p. 200). It thrives under artificial conditions (moist gravel spread over polythene sheeting) in several nurseries in Bedfordshire, Hertfordshire and Buckinghamshire. The new site at Dawlish Warren is the first where it can be regarded as truly naturalised. The habitat is a moist slack under willow trees in a sandy coastal warren. Whether the snail is a recent introduction into Britain remains unclear. (In passing, it may be noted that *Toltecia pusilla* may be synonymous with a common Australasian species *Paralaoma cuputspinulae* (Reeve), in which case the latter name may have to be used.)

Another Mediterranean snail, *Hygromia cinctella*, has turned up in Gloucestershire (a wooded river bank) and in Surrey (a garden; see *Conchologists' Newsletter* no. 111, p. 246). First reported from Paignton in 1950 (*J. Conch., Lond.* **23**, p. 99), it has since become common in South Devon where it has been noted in sixteen 10-km squares. It has also been found in Dorset (in Weymouth, 1982) and in Sussex (at Haywards Heath, 1985). Clearly it is spreading, perhaps helped by the mild winters of recent years.

Among the slugs Stella Davies has confirmed *Arion flagellus* from two more vice-counties and the much scarcer *A. lusitanicus* from a garden in Nottinghamshire. *Boettgerilla pallens* continues its inexorable spread since its discovery in Britain in 1972 and is now common in many parts of England and Wales (47 vice-counties to date).

Among the freshwater species the introduced limpet *Ferrissia wautieri* has been collected in three more vice-counties. The North American planorbid *Menetus dilatatus* has been found in the Lea valley in Hertfordshire, not far from its discovery at Waltham Abbey, Essex, in 1986 (*J. Conch., Lond.* **33**, p. 264). *Anodonta cygnea* has unexpectedly turned up in some abundance in a reservoir in West Cornwall, over seventy miles west of the nearest known populations around Exeter. It is likely to have been introduced with fish infected with the mussel larvae.

Finally a correction. In the last (1982) edition of the Census (*J. Conch., Lond.* **31**, p. 69) *Cerņuella virgata* and *Arianta arbustorum* were listed by mistake for v.c. 71 (Isle of Man). Neither is known from the island.

M. P. KERNEY

COMMUNICATION

INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

Applications published in the Bulletin of Zoological Nomenclature

The following applications were published on 27 March 1990 in Vol. 47, Part 1 of the *Bulletin of Zoological Nomenclature*. Comment or advice on these applications is invited for publication in the *Bulletin* and should be sent to the Executive Secretary, I.C.Z.N., c/o The Natural History Museum, Cromwell Road, London SW7 5BD.

Case 2547

CYMATIINAE Iredale, 1913 (1854) (Mollusca, Gastropoda) and CYMATIINAE Walton in Hutchinson, 1940 (Insecta, Heteroptera): proposal to remove the homonymy

Antti Jansson, Zoological Museum, P. Rautatiekatu 13, SF-00100 Helsinki, Finland. Alan G. Beu, New Zealand Geological Survey, DSIR, PO Box 30368, Lower Hutt, New Zealand

Abstract. The purpose of this application is to remove the homonymy between the molluscan family-group name CYMATIINAE Iredale, 1913 (1854) and the insect family-group name CYMATIINAE Walton in Hutchinson, 1940. It is proposed that the latter be altered to CYMATIINAE by changing the stem of the type genus *Cymatia* from CYMATI- to CYMATIA-.

Case 2641

Limax fibratus Martyn, 1784 et *Nerita hebraea* Martyn, 1786 (actuellement *Placostylus fibratus* et *Natica hebraea*; Mollusca, Gastropoda): conservation proposée pour les noms spécifiques; et *Placostylus* Beck, 1837: désignation proposée de *L. fibratus* comme espèce-type

Philippe Bouchet, Muséum National d'Histoire Naturelle, 55 rue Buffon, Paris, France

Abstract. The purpose of this application is to conserve two gastropod names, *Limax fibratus* Martyn, 1784 and *Nerita hebraea* Martyn, 1786, which were published in *The Universal Conchologist* by T. Martyn (1784–1787), and to designate *L. fibratus* as the type species of *Placostylus* Beck, 1837. Although in use, the specific names are at present formally unavailable because Martyn's work has been rejected as being non-binomial (Opinion 456, March 1957).

Case 2558

Proptera Rafinesque, 1819 (Mollusca, Bivalvia): proposed conservation

Mark E. Gordon, Tennessee Cooperative Fishery Research Unit, Department of Biology, PO Box 5114, Tennessee Technological University, Cookeville, Tennessee 38505, U.S.A.

Abstract. The purpose of this application is to conserve the name *Proptera* Rafinesque, 1819, for a genus of North American freshwater mussels, by the suppression of the senior objective synonym *Potamilus* Rafinesque, 1818.

The following applications were published on 29 June 1990 in Vol. 47, Part 2 of the *Bulletin of Zoological Nomenclature*.

Case 2630

Helix (Helicigona) barbata Férussac, 1832 (currently *Lindholmiola barbata*; Mollusca, Gastropoda): proposed confirmation of lectotype designation

Dietrich Kadolsky, Meadowcroft, 54 Ewell Downs Road, Ewell, Surrey KT17 3BN, UK.

Abstract. The purpose of this application is to conserve the name *barbata* Férussac, 1832 in its accustomed usage for a S.E. European species of pulmonate gastropod. The nomenclature of the nominal taxa *Helix (Helicigona) lens* Férussac, 1832 and *H.(H.) barbata* Férussac, 1832 has recently been reviewed by Gittenberger & Groh (1986), but unfortunately their lectotype selection for *barbata* is not valid under the Code.

Case 2699

RISSOOIDEA (or RISSOACEA) Gray, 1847 (Mollusca, Gastropoda): proposed precedence over TRUNCATELLOIDEA (or TRUNCATELLACEA) Gray, 1840.

G. Rosenberg & G. M. Davies, Academy of Natural Sciences, Philadelphia, Pennsylvania 19103, U.S.A.

Abstract. The purpose of this application is to conserve the family-group name RISSOOIDEA Gray, 1847 for one of the largest superfamilies in the Mollusca. The name is threatened by the senior family-group name TRUNCATELLOIDEA Gray, 1840, over which it is proposed it be given precedence.

Case 1643

Mytilus anatinus Linnaeus, 1758 (currently *Anodonta anatina*; Mollusca, Bivalvia): proposed designation of a neotype.

Peter B. Mordan, The Natural History Museum, Cromwell Road, London SW7 5BD, U.K. Fred R. Woodward, Natural History Department, Art Gallery and Museum, Kelvingrove, Glasgow G3 8AG, U.K.

Abstract. The purpose of this application is to conserve the name *Anodonta anatina* (Linnaeus, 1758) in its accustomed usage for a common species of European freshwater mussel by the designation of a neotype. This will also conserve the name *Pseudanodonta complanata* (Rossmässler, 1835).

INSTRUCTIONS TO AUTHORS

Manuscripts should be sent to:— **The Hon. Editor, Dr B. F. Coles, Windeyer Building, University College and Middlesex School of Medicine, Cleveland St., London W1P 6DB.**

PAPERS Two copies of text and illustrations should be submitted; one set of illustrations must be good quality originals. Authors should refer to recent copies of the *Journal* for a guide to format. Authors are reminded of the high cost of printing and therefore are expected to write concisely and to make maximum use of page size when designing art-work and tables.

COMMUNICATIONS These are intended to be short notes of an original nature which do not merit the treatment of a full paper. *Communications* must not contain any figures, tables or plates and should conform in style to that of recent issues of the *Journal*.

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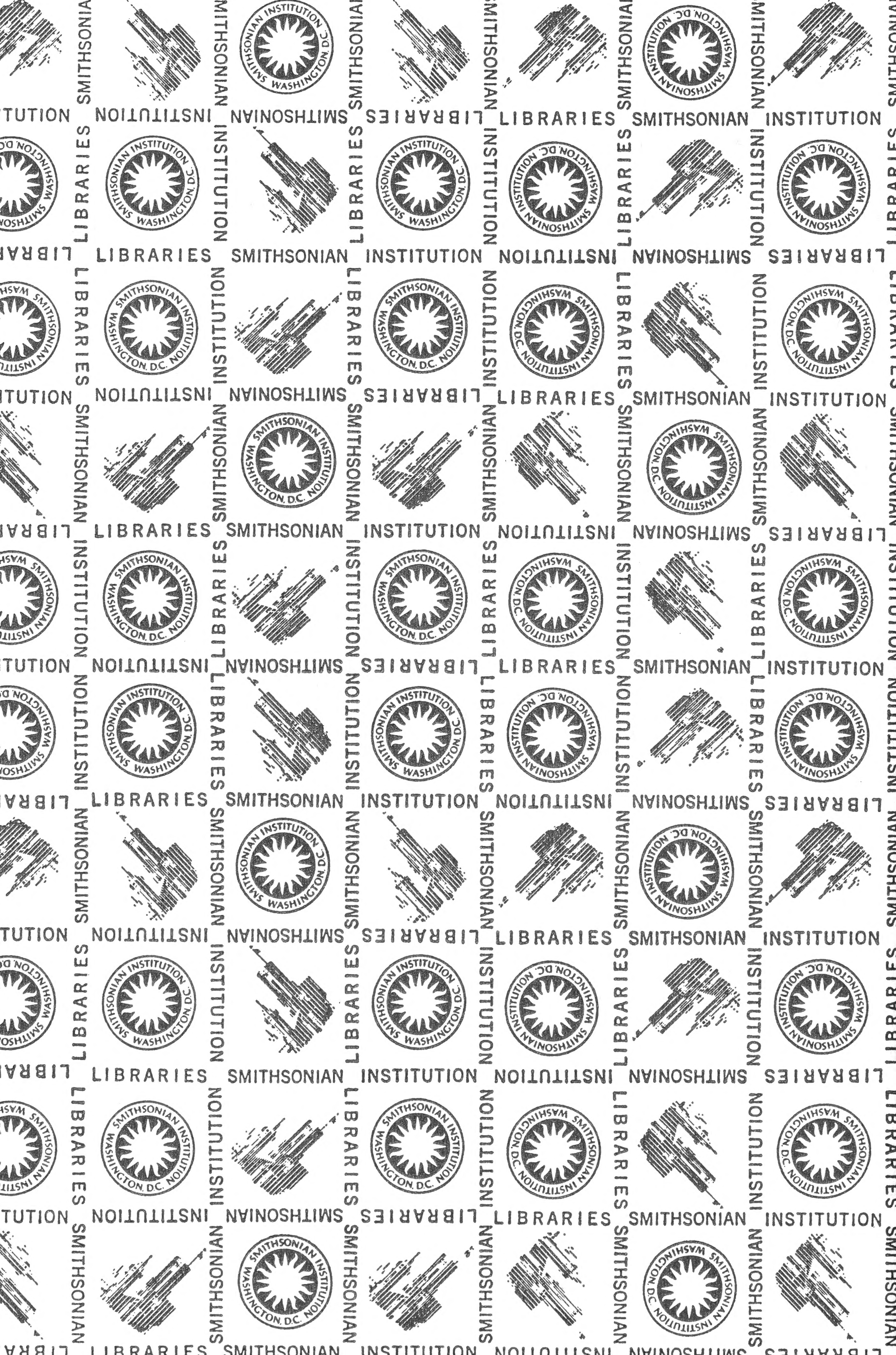
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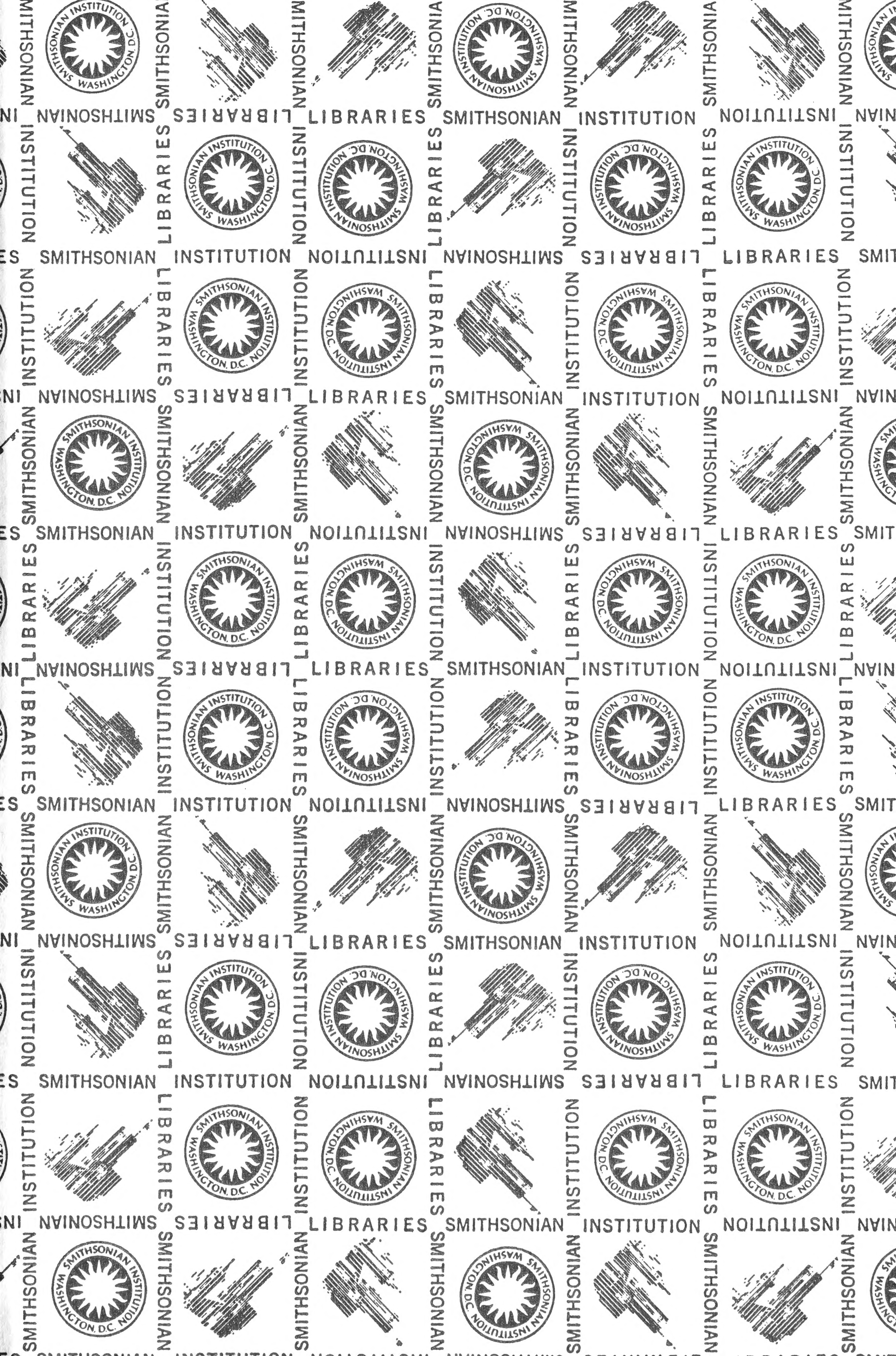
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